Sacramento Regional County Sanitation District Comments on Vol 3-Resource Management Strategies

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To whom it may concern;

Sacramento Regional County Sanitation District (Regional San) is pleased to have this opportunity to provide comments on the attached chapters of Volume 3-Resource Management Strategies. Overall the document is well written and easy to follow. Thank you for providing an easy approach to providing comments, should you have any questions regarding Regional San's comments feel free to contact me.

Take care,

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Chapter 5. Conveyance — Delta

The Delta — A Brief Overview

The Sacramento-San Joaquin River Delta is the confluence point of the Sacramento and San Joaquin rivers as water is naturally conveyed westward from upstream water basins to the bays connected to the Pacific Ocean (Figure 5-1). In its natural state, the Delta was a vast marsh and floodplain dissected by meandering channels and sloughs. Even in today's highly altered environment, the Delta remains a critical ecosystem and dynamic habitat that is home to hundreds of aquatic and terrestrial species, including many species endemic to the area and a number that are designated as threatened or endangered by the federal Endangered Species Act (ESA) and California Endangered Species Act (CESA).

PLACEHOLDER Figure 5-1 Sacramento-San Joaquin River Delta

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of this chapter.]

The Delta is also a centerpiece of California's water system. The conveyance of water through the Delta supplies water for more than 25 million Californians. The water conveyed through the Delta also supports farms and ranches stretching from the north Delta to California-Mexico border, which collectively produce nearly half of the nation's domestically grown fresh produce and supports a $27 billion agricultural industry. In addition to being a key recreational destination, the Delta supports extensive infrastructure of statewide importance, such as aqueducts, natural gas pipelines, electricity transmission lines, railroads, shipping channels, and highways.

Infrastructure Changes to Delta Conveyance — A Brief History

Concerted efforts to control and redirect the flow of water through the Delta began as early as the 1850s. Early water supply diversion projects included the construction of the network of levees that facilitated the conveyance of water for agriculture and human consumption uses. The straightening, widening, and dredging of channels similarly increased shipping access to the Central Valley and improved downstream water conveyance for flood control.

California's post-World War II growth resulted in the planning and construction of two large-scale water projects with an emphasis on conveying water to develop and sustain California's agricultural economy and urban growth. The Central Valley Project (CVP), which was initiated in 1933 and is operated and maintained by the U.S. Bureau of Reclamation (USBR), is comprised of 20 dams and reservoirs with a combined storage capacity of more than 11 million acre-feet, 11 power plants, and more than 500 miles of major canals and aqueducts. The CVP provides sufficient water to irrigate one-third of California's agricultural land and to meet the municipal and industrial needs of close to 1 million households annually.

The State Water Project (SWP), which was initially authorized by voters in 1960 and is operated and maintained by the California Department of Water Resources (DWR), is a complex system comprised of 20 pumping plants, five hydroelectric power plants, 34 storage reservoirs and lakes with combined storage capacity of approximately 5.8 million acre-feet, and approximately 700 miles of pipelines and canals. The SWP provides water for more than 20 million Californians, about 660,000 acres of irrigated farmland, and distributes water under contract to 29 urban and agricultural water suppliers (SWP contractors).

The Delta is a critical component of both water projects, which rely on the Delta conveyance system to provide water at their diversion facilities in the south Delta for use in the San Francisco Bay Area, the Central Valley, and Southern California. Other agencies and facilities, such as the Contra Costa Water District, the East Bay Municipal Utility District, the City of Stockton, and the Folsom South Canal also rely on the Delta as a source of supply or as a transportation corridor for their water supply facilities.

Current Diversion and Future Impacts on the Delta Ecosystem — A Brief Overview

Once a vast marsh and floodplain dissected by meandering channels and sloughs, the Delta provided a dynamic habitat for a rich diversity of fish, wildlife, and plants. The Delta of today has been altered by the construction of levees and reservoirs and dredged waterways to support farming and urban development, as well as to provide flood protection on lands that historically supported marshes and floodplains. The water flow in the Delta is also affected by the movement of water for operations of the SWP and CVP. Many other factors have compounded the alteration of the Delta and include:

- Introduction of invasive non-native fish, wildlife, and plant species.
- Barriers to fish migration.
- Changes in Delta water quality constituents.
- Turbidity and toxicity from both natural and human sources.
- Unscreened power plant and agricultural diversion.
- Changed water salinity due primarily to reduced Delta outflow and increased agricultural runoff.
- Illegal fish harvesting.
- Improper fish hatchery management practices.

The Delta's future will be affected by increasing land subsidence, heightened seismic risk, and possible effects of climate change which include rising temperatures, changes in runoff timing, sea level rise, and changes in storm timing, intensity, and frequency.

In this highly altered environment, several fish species have declined to the lowest population numbers in their recorded histories. In response, federal regulatory actions to protect threatened and endangered fish species have limited through-Delta conveyance and have made water supplies increasingly variable.

The Bay Delta Conservation Plan (BDCP) — Achieving the Coequal Goals Ecosystem Restoration and Water Supply Reliability

Brief History and Purpose of the BDCP

During the past several decades, the increasing demand for the Delta's resources has escalated the conflict between the needs of water users and the efforts to sustain the estuary's aquatic ecosystem and support the protection of state and federally threatened or endangered fish. These conflicts have led to a crisis regarding the ability to protect Delta fisheries, maintain water quality, and meet the needs of both in-Delta and export area agricultural and municipal water users. This situation has resulted in the need to address these competing beneficial uses and sustainability concerns.

The Sacramento-San Joaquin Delta Reform Act of 2009 (Delta Reform Act) mandates developing a comprehensive Delta management plan (Delta Plan) with the coequal goals of (1) protecting, restoring, and enhancing the Delta ecosystem, and (2) providing a more reliable water supply for California. The proposed Bay Delta Conservation Plan (BDCP) is anticipated to be the 50-year comprehensive conservation strategy component of the Delta Plan.

The Delta Reform Act establishes the framework to achieve the coequal goals of providing a more reliable water supply and restoring and enhancing the Delta ecosystem. The coequal goals will be achieved in a manner that protects the unique cultural, recreational, natural resource, and agricultural values of the Delta. The Delta Reform Act creates the Delta Stewardship Council, ensures the Department of Fish and Wildlife and State Water Resources Control Board identify the water supply needs of the Delta estuary for use in determining the appropriate water diversion amounts associated with the BDCP, establishes the Sacramento-San Joaquin Delta Conservancy to implement ecosystem restoration activities within the Delta, restructures the current Delta Protection Commission, and appropriates funding from Proposition 84.

The Delta Stewardship Council will develop the Delta Plan, which furthers the coequal goals of Delta restoration and water supply reliability, which includes determining the consistency of the BDCP with coequal goals.

The BDCP is being developed in compliance with the federal ESA, the CESA, and the Natural Community Conservation Plan (NCCP). The BDCP's comprehensive conservation plan is also undergoing intensive environmental review in the form of both a state Environmental Impact Report (EIR) and a federal Environmental Impact Statement (EIS). The EIR and EIS will evaluate the conservation plan's impact on all aspects of the environment and will identify alternatives and mitigation actions.

Delta Ecosystem Restoration and Protection — The Conservation Plan

The federal and state ESAs presently regulate the operational impacts of the SWP and CVP on a species-by-species basis. The BDCP is a joint habitat conservation plan (HCP) and Natural Community Conservation Plan (NCCP) that seeks to improve the health of the Delta's ecological system using a comprehensive conservation strategy to address the collective impacts associated with the SWP, CVP, and certain existing and anticipated future actions within the area covered by the BDCP. The BDCP takes into account multiple stressors on the ecosystem, the needs of multiple species, and the diverse natural communities that support them, including species listed under the federal and state ESAs as threatened, endangered, or candidates for listing, inclusive of habitat, if any, designated for these species.

The BDCP aims to enhance the Delta's ecosystem processes and function, including seasonal floodplain habitat, intertidal and associated subtidal habitat, hydrologic conditions, and salinity within the Delta estuary including a reduction in the direct loss of fish and other aquatic organisms. Specific problems to be addressed include the reconnection of floodplains, the development of new tidal marsh habitat, the restoration of river banks to a more natural state, invasive species control, decreasing water toxicity levels, and aligning water operations to reflect natural seasonal flow patterns better.

An overriding goal of the BDCP is to contribute to the recovery of at-risk species in the Delta. The BDCP seeks to accomplish this goal by identifying specific conservation and management actions, or conservation measures, to improve habitat conditions within the Delta's natural communities. The overall BDCP conservation strategy presently includes 22 conservation measures that are designed to achieve biological goals and objectives specific to 11 conservation zones comprising the Delta.

BDCP — Taking Conveyance a New Direction

Central to the BDCP is the proposal to develop an improved conveyance system, which differs from past water plans and implements a conveyance strategy that takes into account the continued decline in the Delta ecosystem. Specifically, the BCDP proposes the creation of dual water conveyance delivery system comprised of the existing (through-Delta) conveyance and a new conveyance system that will route water through an isolated facility conveyance system to be exported via the SWP and CVP. As proposed, the North Delta Diversion would become the primary diversion point and would be subject to water delivery operation rules. The new facility would help meet the dual, coequal goals of the Delta Plan by providing for a more reliable supply of water while simultaneously maintaining sufficient bypass flows for state and federally listed species of concern.

Water Supply Reliability

There are many factors that influence water supply reliability. The distribution of precipitation and water demand in California is unbalanced because most of the state's precipitation falls in the north and a substantial amount of the state's water demand is south and west of the Delta. This includes irrigation water for southern Central Valley agriculture, and municipal and industrial uses in Southern California and the Bay Area. Additionally, federal and state mandated regulatory actions to protect threatened and endangered species in the Delta have further limited the levels of through-Delta water conveyance, which makes available water supplies even more unreliable.

To compound these challenges further, the Delta is not a static ecological system and fundamental changes are certain to occur. The anticipated effects of climate change indicate elevated sea levels, altered annual and inter-annual hydrological cycles, changed salinity, and water temperature regimes in and around the Delta, and accelerated shifts in species composition and distribution. These changes further add to the difficulty of resolving the increasingly intensifying conflict between the ecological needs of at-risk Delta species and natural communities and the need to provide adequate and reliable water supplies for people, communities, agriculture, and industry. Anticipating, preparing for, and adapting to these changes are key underlying drivers associated with implementation of the proposed Bay Delta Conservation Plan.

Existing Delta conveyance does not provide long-term reliability to meet current and projected needs. Conveyance through the Delta during drought is especially challenging considering the various demands from agriculture, municipalities, and environmental needs. To improve through-Delta conveyance water supply reliability, provide greater operational flexibility, and improve ecosystem function, improvements to existing facilities by updating aging infrastructure, increasing existing capacities, adding redundancy to the system, constructing additional facilities, and restoration of habitat may be needed.

The major issues pertaining to reliability of water supply transferred through the Delta include the following items:

- The health of the Delta ecosystem is paramount considering water-related activities within the Delta. Continuing declines in some native species populations migrating through or living in the Delta, such as salmon and delta smelt, highlight the increasing influence of the Delta ecosystem on water supply reliability. Any activity proposed for Delta conveyance will need to consider the restoration and preservation of native habitat.
- The integrity of more than 385 miles of Project levees and over 730 miles of non-Project levees throughout the Delta is continually undermined by such elements as storm events creating floods and seawater surges, island subsidence, natural levee erosion, poor quality peat soils used to build the original levees, seismic activity, burrowing animals, and sea level rise. These vulnerabilities call into question the long-term sustainability of using the Delta as a conveyance corridor.
- DWR's Delta Risk Management Strategy Phase II report recommends levee standards for the Delta to increase through-Delta water supply reliability and reduce risks to water conveyance and other values in the Delta overall.
- Maintaining optimal water quality within the Delta for both drinking water and for native species habitat is paramount. Constituents of concern include, but are not limited to, salinity, bromide, chloride, organic carbon, nutrients, pathogens, dissolved oxygen, temperature, and turbidity. Control of water quality in a tidal estuary with seasonal and yearly fluctuating hydrology will require well-understood and fully inclusive strategies. As water quality requirements can vary, and at times conflict among users, the challenge will be to agree upon the implementation strategy.
- Maintenance of in-Delta projects for beneficial uses such as recreational boating and swimming, sport fishing, shipping, and agriculture, industrial, and drinking water supply will be an ongoing management challenge as political and fiscal climates evolve and resources for competing priorities become scarcer.

Potential Benefits

Implementation of the proposed dual conveyance improvements will enable the operational flexibility. The use of an alternative conveyance strategy will also allow for the restoration of a more natural flow of the waters feeding into and across the Delta east to west toward the Pacific Ocean.

Key beneficial effects in the Plan Area:

- Improve south Delta flows.
- Restore more than 100,000 acres of natural communities to promote improved ecosystem function.
- Provide increased climate change adaptation in the Plan Area.
- Reduce north to south flows for exports.
- Reduce other stressors such as stranding, invasive aquatic species, localized predation, and low dissolved oxygen.
- No changes in water temperatures; no biologically meaningful changes in salinity.

Net beneficial effects on aquatic species:

- Increase suitable habitat such as restored tidal and channel margin habitat.
- Increase food sources and availability from restored habitat.

- Decreased entrainment.
- Reduced entry into interior Delta.
- Reduced predation.
- Reduced illegal harvest.

Potential Costs

Dual Conveyance — Implementation Costs and Funding Sources

A detailed discussion of the estimated costs associated with the implementation of the BDCP over the proposed 50-year term of the conservation plan is in Chapter 8 of the proposed Bay Delta Conservation Plan at http://baydeltaconservationplan.com/.

Major Implementation Issues

While conservation plans like the BDCP are meant to be beneficial to the environment, specific actions in the plan can have an impact on natural and human environments. These impacts must be evaluated and actions identified to mitigate them. State and federal environmental laws require a review of potential impacts of the BDCP before it is approved and implemented.

The BDCP Environmental Impact Report/Environmental Impact Statement (EIR/EIS) was prepared in compliance with the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA).

The term “mitigation” is specifically applied in the EIR/ EIS as measures used to reduce environmental impacts after considering all of the environmental commitments described for each resource. Additional mitigation options and opportunities are being discussed with lead and cooperating agencies. The significant and unavoidable impacts listed in the April 2013 Consultant Administrative Draft EIR/EIS may be reduced to a less-than-significant level by the time of the Public Draft EIR/EIS is issued.

Climate Change

Northern California is expected to experience changes to the physical environment as a result of climate change. It is expected that climate change will result in more precipitation falling as rain rather than snow, leading to reduced snowpack, earlier snowmelt, and reduced river flows and reservoir storage in summer, causing changes to the seasonal timing of flows in rivers. Air temperatures will continue to rise, which will increase water temperatures. Accelerated rates of relative sea level rise will increase the intrusion of seawater into the upper estuary and when combined with an increase in coastal storms, storm surge, and river runoff will increase shoreline flooding and erosion. Sea level rise will continue to threaten infrastructure, increase flooding at the mouths of rivers, place additional stress on levees in the Delta, and will intensify the difficulty of managing the Delta as the heart of the state’s water supply system.

Adaptation

Both the increase in winter runoff and more intense storm events that are anticipated with climate change may require larger conveyance capacity and reservoir storage to manage water successfully for flood risk reduction and water supply reliability. Delta conveyance improvements can provide additional resiliency for minimizing these impacts while providing more flexibility in managing water supplies and reducing flood risk, while achieving the coequal goals. Expected climate change adaptation benefits of Delta conveyance improvements include:

- Enhanced ecosystem services through restoration of wetlands, floodplains, and riparian habitats will restore ecosystem services that benefit humans as well as ecosystems.
- Increased protection of upland habitat and structures from flooding and storm surges due to sea level rise.
- Improved floodplain connections to rivers to restore the ability of floodplains to absorb flood flows and to provide a water reservoir to help aquatic species withstand droughts.
- Increased resilience to invasive species from creation of seasonally inundated floodplains by increasing numbers and health of native species and excluding invasive species.
- Increased habitat variability helping to support species diversity by providing a mosaic of habitats that can be used by different species that have evolved to use specific habitats.
- Increased habitat complexity from wetland restoration, which will include networks of channels within marshes that are used by fish for foraging, refuge, and movement in and out of the marsh.
- Increased habitat patch size and connectivity through the protection and restoration of a variety of natural communities. Increasing patch size will tend to increase population sizes of native species, which provides more resiliency against a changing climate.
- Additional flexibility in managing water supplies under more frequent dry conditions and periods of prolonged drought.

Mitigation

Despite the overall positive benefits of the BDCP Conservation Strategies, implementation will result in some negative impacts. For example, there are tradeoffs between BDCP environmental benefits with its negative impacts on greenhouse gas (GHG) emissions from construction as well as potential indirect project effects from growth and development. As stated in the EIR/EIS, BDCP will develop a GHG Mitigation Program prior to the commencement of any construction or other physical activities associated with water facilities and operations that would generate GHG emissions. The GHG Mitigation Program will consist of feasible options that, taken together, will reduce construction-related GHG emissions to net zero (i.e., emissions will be reduced to the maximum extent feasible and any remaining emissions from the project will be offset elsewhere by emissions reductions of equal amount). The BDCP proponents will determine the nature and form of the components of the GHG Mitigation Program after consultation with the various local air control agencies.

As a part of ongoing operations of the Delta conveyance, improving conveyance system efficiency could reduce energy use in pumping plants, power supply, and water diversion, which contributes to GHG reduction for climate change mitigation. Furthermore, promoting water conservation, efficiency, and sustainable use will also reduce energy use for GHG reduction that is beneficial for climate change mitigation.

Recommendations

As one of California's most invaluable natural resources, the Delta has been stretched to the breaking point. The Delta ecosystem is in steep decline, which jeopardizes the native fish and wildlife species, threatened reliable water supplies for millions of Californians, and puts the state's broader economy at serious risk. In order to reach the coequal goals necessary to successfully improved Delta conveyance, the following recommendations include:

1. Legally acknowledge the coequal status of restoring the Delta ecosystem and creating a more reliable water supply for California.
2. Recognize and enhance the unique cultural, recreational, and agricultural values of the Delta as an evolving place.
3. Restore the Delta ecosystem as the heart of a healthy estuary.
4. Promote water conservation, efficiency, and sustainable use.
5. Build facilities to improve the existing water conveyance system and expand statewide storage, and operate both to achieve the coequal goal.
6. Reduce risks to people, property, and state interests in the Delta by effective emergency preparedness, appropriate land uses, and strategic levee investments.
7. The California Urban Water Management Planning Act requires urban water suppliers to adopt water management plans every 5 years and submit to DWR. In these plans, urban water suppliers must assess whether their current and planned water supplies will be enough to meet the water demands during the next 20 years. DWR is required to review local water management plans and report on the status of these plans.
8. The Water Conservation Act of 2009 includes distinct requirements related to both urban and agricultural water use. DWR is required to report on progress toward meeting urban per capita water use goals.
9. Through its Agricultural Water Management Planning and Implementation Program, DWR helps water districts develop agricultural water management plans and implement cost-effective efficient water management practices.
10. DWR will participate in workshops and technical discussions about managing for extreme drought and floods.

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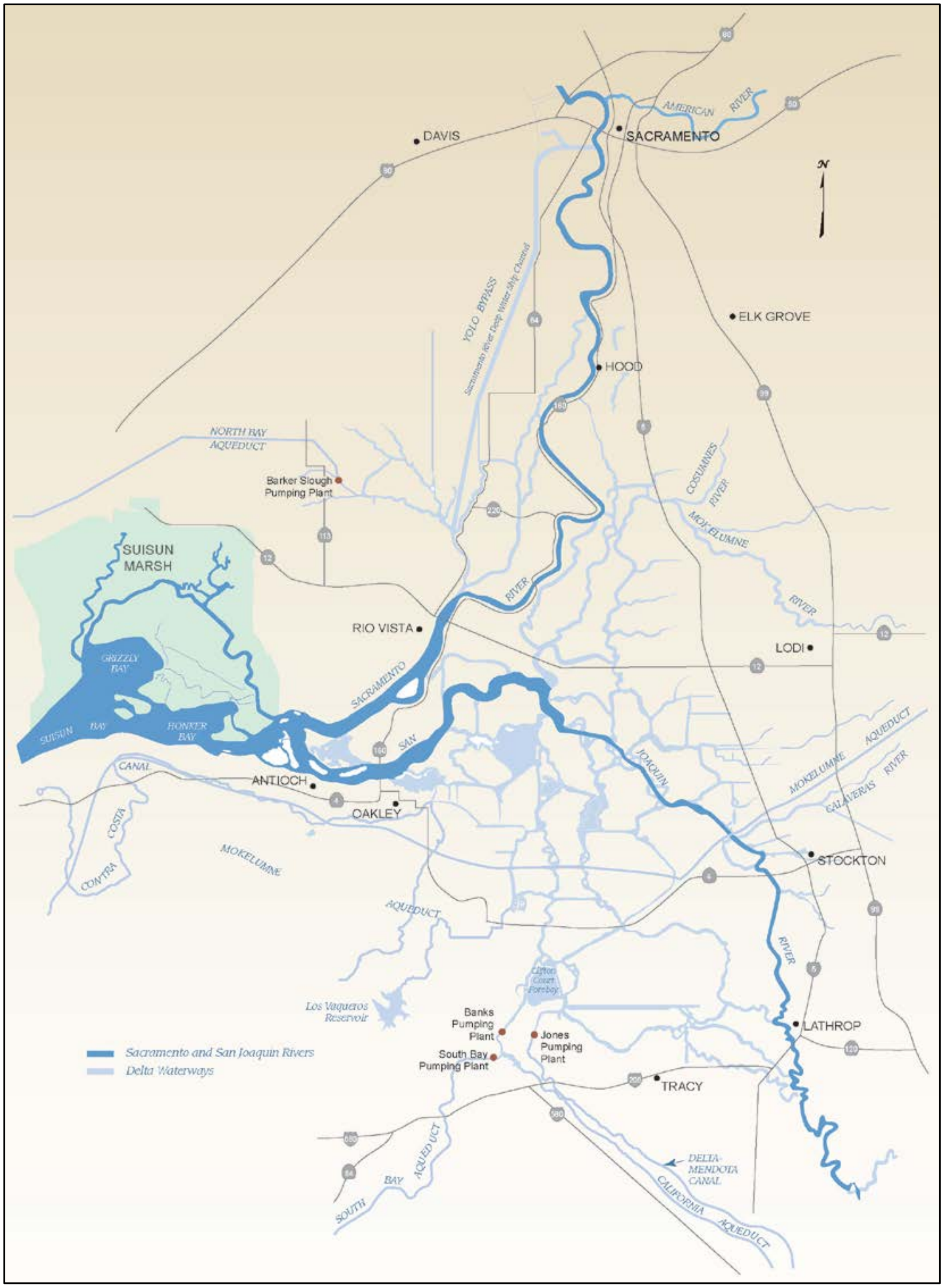
Figure 5-1 Sacramento-San Joaquin River Delta



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Chapter 15. Drinking Water Treatment and Distribution

Providing a reliable supply of safe drinking water is the primary goal of public water systems in California. To achieve this goal, public water systems must develop and maintain adequate water treatment and distribution facilities. In addition, the reliability, quality, and safety of the raw water supply are critical to achieving this goal. In general, public water systems depend greatly on the work of other entities to help protect and maintain the quality of the raw water supply. Many agencies and organizations have a role in protecting water supplies in California. For example, the basin plans developed by the Regional Water Quality Control Boards recognize the importance of this goal and emphasize protecting water supplies —both groundwater and surface water.

A public water system is defined as a system for the provision of water for human consumption, through pipes or other constructed conveyances, which has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days of the year (Health and Safety Code, Section 116275[h]).

Public water systems (PWS) are divided into three principle classifications: community water systems (CWS), non-transient non-community (NTNC) water systems, and transient non-community (TNC) water systems. As the name indicates, CWS serve cities, towns, and other residential facilities occupied by year-round users. Examples include everything from apartment complexes served by their own well to systems serving California's largest cities. NTNC systems are PWS that are not CWS and provide water to the same non-residential users daily for at least 180 days of the year. Examples include schools, places of employment, and institutions. TNC systems are places that provide water for a population that mostly comes and goes. Examples include campgrounds, parks, ski resorts, rest stops, gas stations, and motels. Table 15-1 shows the number of public water systems in California by class. Community water systems serve approximately 36.6 million of the estimated 37.7 million people throughout the state, or 97 percent of the state's population. The remaining estimated 1.1 million people in the state (3 percent of the population) receive their drinking water from private wells serving their individual residences or from other sources. Virtually every Californian and visitor to the state will use drinking water from a regulated PWS through their work, while on vacation, or while traveling through the state. Figure 15-1 shows water system class by percent of total number of public water systems in California.

PLACEHOLDER Table 15-1 Public Water Systems in California by Class

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

PLACEHOLDER Figure 15-1 Public Water System Class by Percentage of Systems

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Under the California Safe Drinking Water Act (SDWA), the California Department of Public Health (CDPH) or CDPH Drinking Water Program has adopted regulations to ensure high quality drinking water is provided by public water systems at all times. In developing drinking water regulations and carrying out the public water system regulatory program, CDPH recognizes that healthy individuals and communities cannot exist without safe, reliable water supplies. These actions are necessary not only for drinking water, but also to meet basic sanitary and public safety needs.

Drinking water regulations mandated by the California SDWA apply to all public water systems, regardless of ownership. There are two basic water system ownership types - publicly owned and privately owned. Publicly owned systems include municipalities, special districts, and federal or state government systems. Privately owned systems include investor-owned utilities, mutual water companies, mobile home parks, water associations, and may include various commercial enterprises such as restaurants, hotels, resorts, employee housing, or other similar businesses that have their own water supply. While CDPH regulates all public water systems for all aspects that may affect water quality regardless of ownership, the California Public Utilities Commission (CPUC) regulates privately owned, for-profit systems serving communities for the purposes of establishing appropriate water rates. The CPUC regulates sole proprietorships, partnerships, and corporations that provide water service to the public for profit. Mutually owned systems and homeowners associations are exempt from CPUC oversight if they provide water only to their stockholders or members. In addition, systems serving privately owned mobile home parks are also exempt except that CPUC may conduct an investigation into water rate abuses when they receive complaints from residents. Table 15-2 provides a summary of the number and size of the CPUC-regulated water systems.

PLACEHOLDER Table 15-2 Number and Type of CPUC–Regulated Water Agencies

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

At the federal level, the U.S. Environmental Protection Agency (U.S. EPA) is responsible to ensure the implementation of the federal SDWA and related regulations. The State has primacy for the public water system regulatory program in California and works closely with U.S. EPA to implement the program. In addition, local primacy agencies (typically the county environmental health departments) are responsible for regulating many small public water systems (typically those serving less than 200 homes) in 32 of the 58 California counties. U.S. EPA directly provides regulatory oversight for tribal water systems.

Public water systems rely on groundwater, surface water, or a combination of both as their source of supply. Groundwater wells used for drinking water are constructed in a manner to intercept high quality groundwater. Therefore, many groundwater wells require little to no treatment. However, some groundwater wells are impacted by anthropogenic (manmade) and/or naturally occurring contaminants that require treatment to achieve the high level of quality mandated by state and federal regulations for a safe, reliable water supply. All surface water supplies used for drinking water must receive a high level of treatment to remove pathogens, sediment, and other contaminants before being suitable for consumption. Once the water is treated to drinking water standards, this high level of water quality must be maintained as the water passes through the distribution system to customer taps. Water treatment and distribution issues are discussed in detail later in this chapter. There is an increasing effort aimed at preventing pollution and matching water quality to water use. This is described in this volume in Chapter 18, Pollution Prevention and in Chapter 17, Matching Water Quality to Use.

The use of bottled water in the United States has been an increasing trend, however recently that trend appears to have flattened from 2007 through 2011. The Beverage Marketing Corporation and International Bottled Water Association report that U.S. consumption of bottled water was 29.2 gallons per person in 2011 and 29.0 gallons per capita in 2007. In 2005, California ranked No 1 in the nation for percent of the bottled water share (23.9 percent) and was ranked No. 3 behind Arizona and Louisiana for per capita consumption at 51.2 gallons (Donoho 2007). Some of the reasons that individuals choose bottled water include convenience, image, taste, and perceived health benefits. On the other hand, many consumers are becoming aware of the environmental impact associated with the production, transportation, and waste disposal of bottled water including the contributions to greenhouse gas emissions. While tap water and bottled water are regulated differently, both are generally safe, healthy choices. Tap water provided by a public water system yields public health and fire protection among its other advantages to a modern quality of life. Bottled water costs significantly more than tap water for the volume consumed in cooking and drinking.

Bottled water is regulated by the U.S. Food and Drug Administration under the 1938 Food, Drug, and Cosmetic Act (FD&C Act). California regulates bottled and vended water to a much greater degree than provided in the FD&C Act. The California Sherman Food, Drug, and Cosmetic Law is the basic statute that authorizes such regulation and is implemented by the CDPH Food and Drug Branch.

Drinking Water Treatment in California

Public Health

Water treatment includes processes that treat, blend, or condition the water supply of a public water system for the purpose of meeting primary and secondary drinking water standards. These processes include a wide range of facilities to treat surface water and groundwater. Common surface water treatment facilities include: basic chlorine disinfection, sedimentation basins, filtration, and more recent technical advances such as membrane filtration, ultraviolet light, and ozonation to meet pathogen removal and/or inactivation as well as disinfection requirements while controlling the formation of disinfection byproducts. Common facilities for groundwater sources that require treatment are chemical removal and/or blending facilities. Blending treatment is an acceptable practice for meeting chemical water quality standards and is a process of reducing the contaminant concentration in one water source by blending or dilution with water that has a lower contaminant concentration. Many water systems must also buffer or adjust the pH of the water to ensure that the delivered water is not corrosive in the distribution system and customers' piping. Fluoridation treatment, now commonly practiced in California, may be used to add fluoride to an optimal level that provides dental health benefits.

Widespread treatment of drinking water, especially disinfection, filtration, and fluoridation, was a great public health advancement of the 20th century. The 21st century promises to bring additional advances in water treatment technologies to improve the removal of contaminants, reduce cost the cost per gallon of treated water, improve water use efficiency (increase water recovery and reduce waste streams), and manage energy consumption. Water recovery, or recycling of water containing treatment process wastes (i.e., filter backwash water, filter rinse water) that would otherwise be disposed, begins with treatment of the recovered or recycled water so it may be blended with raw untreated water at the start of the treatment plant process. This enables a larger percentage of a water supply to be converted to potable water and concentrates the solids generated at the treatment plant. It is important for treatment processes in water-short areas to maximize the amount of a water supply that can be converted to potable water by reducing the amount of water that is discharged as waste.

California public water systems use an estimated 17,983 groundwater wells and surface water supplies to meet the water supply needs of consumers. Some of these sources need treatment to remove or inactivate harmful contaminants or to meet either aesthetic quality prior to consumption. These could include minerals, metals, chemicals from industry or agriculture, pathogens, and radiological constituents. Currently, there are an estimated 8,560 water treatment facilities in California. Most of these are disinfection facilities provided at sources, treated water storage tanks, or within the distribution system. The remaining systems provide more extensive treatment summarized in Table 15-3.

PLACEHOLDER Table 15-3 Treatment Plants on California Public Water System Sources

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Fluoridation

Fluoridation of community drinking water has been practiced in the United States for more than 60 years. It is accepted as a safe and effective public health practice for people of all ages. The previous five U.S. Surgeons General have recommended that communities fluoridate their water to prevent tooth decay, the major form of preventable dental disease in America. California's fluoridated drinking water act, Assembly Bill 733, became law in 1995 and required water systems with 10,000 or more service connections to fluoridate once money from an outside source is provided for both installation and operation and maintenance costs. CDPH is also responsible for identifying funds to purchase and install fluoridation equipment for public water systems.

During fluoridation treatment of public water system supplies, water systems adjust fluoride in drinking water to an optimal level shown to reduce the instances of tooth decay. Optimal fluoridation means that the water treatment facility and distribution system is closely managed to provide a consistent level of fluoride at the appropriate prophylactic level to reduce dental disease. Other water systems, that purchase water from a wholesale provider that fluoridates, provide variable fluoridation at levels up to the optimal level. The level of fluoride in these systems depends on many factors, including time of year, water demand, and the use of sources that may not have fluoridation treatment facilities. Additional information on water systems that provide fluoridated water is available at http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Fluoridation.aspx.

Regulation

Both the U.S. EPA and CDPH have ongoing programs for improving public health through new or more stringent drinking water regulations. These regulations include monitoring requirements, maximum contaminant levels (MCLs) in the water provided to the customer, multi-barrier treatment requirements, permitting requirements, public notification, and more. These regulations include specific MCLs for constituents of health concern that are present in drinking water sources. In California, new drinking water standards—the MCLs—are adopted only after development of a Public Health Goal (PHG), which is the level of a contaminant in drinking water below which there is no known or expected risk to health. PHGs are set by the Office of Environmental Health Hazards Assessment, an agency under the California Environmental Protection Agency (Cal EPA). MCLs take into account not only chemicals' health risks, but also factors such as their detectability and treatability, as well as costs of treatment. The California Health and Safety Code requires CDPH to establish a contaminant's MCL at a level as close to its PHG as is technically and economically feasible, placing primary emphasis on the protection of public health.

In some cases, California adopted MCLs in advance of the federal adoption of an MCL. For example, CDPH adopted a perchlorate MCL of 6 µg/L in 2007. This MCL is based primarily on potential adverse effects on the thyroid. In 2008, the U.S. EPA indicated that it did not intend to adopt an MCL for perchlorate. However, in 2011 the U.S. EPA reversed its earlier decision and now plans to propose a formal rule for perchlorate (U.S. EPA 2011). In September 2012, U.S. EPA posted a Federal Register notice of a public meeting regarding their intent to regulate perchlorate levels in drinking water through adoption of an MCL and anticipates that a draft rule will be available for public comment in 2013.

CDPH is currently in the regulation process to establish an MCL for chromium-6. On July 1, 2011, Cal EPA's Office of Environmental Health Hazard Assessment completed the setting of a PHG for chromium-6 at a concentration of 0.02 µg/l, a necessary prerequisite to adopt an MCL. CDPH is required by law to establish MCLs that are as close to a PHG as are technically and economically feasible. CDPH anticipates that a draft MCL for chromium-6 will be ready for public comment by July 2013. Depending on public comments, the regulatory package for chromium-6 should be formally adopted sometime between July 2014 and July 2015.

In addition, if the adoption of a specific MCL is not practical, U.S. EPA and CDPH have adopted specific treatment performance standards that essentially take the place of an MCL. An example of this is in the various rules for surface water treatment that are intended to provide protection against *Giardia* and *Cryptosporidium*, two microbial contaminants found in surface waters where direct testing is impractical, costly, or lacks the level of reliability necessary in setting an MCL.

New Technology

New or innovative treatment technologies are often developed to address new or more stringent drinking water standards, improve the contaminant removal efficiency, reduce treatment plant footprint, reduce energy consumption, or reduce/eliminate waste streams from the treatment process. Innovative environmental technologies hold the promise of being more effective than traditional methods and can address today's far more complex environmental problems. Technologies increasingly used in California as a result of new regulations include:

- Ultraviolet (UV) disinfection treatment to comply with disinfection byproducts under the Stage 2 Disinfection Byproducts Rule and requirements for the treatment of surface waters under the Long Term 2 Enhanced Surface Water Treatment Rule.
- Arsenic removal technologies including adsorptive (disposable) media to increase affordability of small water system compliance with the arsenic MCL.
- Membrane filtration to comply with requirements of the Long Term 1 and Long Term 2 Enhanced Surface Water Treatment Rules.
- Biological treatment in the form of fixed bed, fluidized bed, and membrane bioreactors to treat for perchlorate and now being demonstrated for nitrate and other contaminants.

As a result of both increases in demand and the relative scarcity of new water supplies, many water providers are now shifting toward treating sources formerly considered unsuitable for domestic use.

Treatment processes such as reverse osmosis are used to desalt brackish shallow groundwater for potable uses and are discussed in greater detail in Chapter 10, Desalination – Brackish Water and Seawater in this volume.

Drinking Water Distribution in California

Treated and/or conditioned water that meets drinking water standards is considered to be "finished water", suitable for distribution to consumers for all potable water uses. Water distribution systems consist of pipes, storage tanks, pumps, and other physical features that deliver water from the source or the water treatment plant to the customer's connection. Even high quality drinking water is subject to degradation as it moves through the distribution system to the tap. For example, contaminants can enter the distribution system via backflow from a cross-connection, permeation and leaching, during water main repair or replacement activities, and contamination via finished water storage facilities. Within the distribution system, water quality may deteriorate as a result of microbial growth and biofilm, nitrification, corrosion, water age, effects of treatment on nutrient availability contributing to microbial growth and biofilm, and sediments and scale within the distribution system (U.S EPA 2006).

CDPH has established laws and regulations for the design, construction, operation, and maintenance of distribution systems primarily through the California Waterworks Standards (California Department of Public Health 2008a). Regulations mandate monitoring distribution system water quality for coliform bacteria, chlorine residual, lead, copper, physical water quality parameters, and disinfection byproducts. California has also adopted cross-connection control and backflow prevention regulations to protect water quality within a water distribution system.

In 2000, a federal advisory committee working to develop more stringent U.S. EPA regulations for disinfection byproducts and microbial contamination noted the following as part of its key considerations to develop further regulations in these areas:

- Finished water storage and distribution systems may have an impact on water quality and may pose risks to public health.
- Cross-connections and backflow in distribution systems represent a significant public health risk.
- Water quality problems can be related to infrastructure problems and the aging of distribution systems may increase risks of infrastructure problems.
- Distribution systems are highly complex and there is a significant need for additional information and analysis on the nature and magnitude of risk associated with them.

The maintenance of water quality within the distribution system has received considerable attention in recent years, especially as systems have modified treatment methods. Changes to the methods and levels of disinfectants can create the potential for reduced control of microbial contaminants that may be present in the distribution system.

Water utilities are also constantly making improvements to their distribution systems, including increasing the reliability of their water supply. One example is the installation of emergency water interties between neighboring water utilities. These interties provide a backup source, with the neighboring water system, in case of an outage due to an unforeseen emergency or a potential disaster.

The intertie also allows a water utility to shut down a part of its system to do necessary maintenance without interrupting service to customers.

For example, a number of Bay Area water systems have constructed emergency interties with neighboring water systems. There is an emergency intertie between the East Bay Municipal Utility District (EBMUD), the City of Hayward, and the San Francisco Public Utilities Commission (SFPUC) to supply treated water among the three water systems and is intended to be used during planned outages, for needed maintenance, and to avoid service interruptions. EBMUD has two small interties, each able to carry 4 million gallons per day, with the City of Hayward which adjoins its service area. SFPUC, the agency in charge of the Hetch Hetchy water used by many Bay Area water districts and residents, has also constructed an intertie with the Santa Clara Valley Water Agency and has been considering constructing another intertie. These interties may also play a role in the security of the water distribution system by creating a backup source should a terrorist act or disaster disrupt the source of supply from any single water provider.

In other cases, interties can provide untreated water between utilities in an emergency. For example, Contra Costa Water District (CCWD), whose service area is crossed by EBMUD Mokelumne pipeline, has an intertie which can be used to transfer untreated water between EBMUD and CCWD in an emergency.

Interties are one of the strategies for improving water supply reliability and quality which were recommended by the CALFED August 28, 2000 Record of Decision.

Potential Benefits

Improved water quality can directly improve the health of Californians, thereby improving the state's standard of living and reducing the burden and costs on the state's healthcare system.

Since 1989, a number of rules have been adopted by U.S. EPA and CDPH that are aimed at controlling both microbial pathogens and disinfection byproducts. The first of these rules were the Surface Water Treatment Rule (1989) and the Total Coliform Rule (1989). Both rules intended to reduce the risk to consumer of both viral and microbial pathogens in drinking water. As the regulatory community became more aware of the risks posed by organisms such as *Giardia*, *Cryptosporidium*, and certain enteric viruses present in surface water supplies, rules were adopted to address these risks and increase the degree of protection for consumers. These rules included:

- Interim Enhanced Surface Water Treatment Rule (1998).
- Filter Backwash Rule (2001).
- Long Term 1 Enhanced Surface Water Treatment Rule (2002).
- Long Term 2 Enhanced Surface Water Treatment Rule (2005).

Concurrently, rules were adopted to improve the disinfection process while at the same time providing protection against two groups of disinfection byproducts, trihalomethanes (TTHM) and haloacetic acids (HAA5). The following disinfection byproduct rules were adopted:

- Stage 1 Disinfection Byproducts Rule (1998).
- Stage 2 Disinfection Byproducts Rule (2006).

In addition to the surface water rules, U.S. EPA adopted the Groundwater Rule (2006) to increase the level of protection primarily from enteric viruses.

The perchlorate MCL and the arsenic MCL reduce the permissible level of these contaminants and result in direct benefits. Perchlorate exposure is a public health concern because it interferes with the thyroid gland's ability to produce hormones. In the very young, hormones are needed for normal prenatal and postnatal growth and development, particularly for normal brain development. Therefore, a reduction in thyroid hormones is a serious concern. In adults, thyroid hormones are needed for normal body metabolism. About 515,000 people in California will avoid exposure to perchlorate at levels above the MCL annually as a direct result of the perchlorate regulation (California Department of Public Health 2007). The arsenic MCL of 10 ug/L will result in an exposure reduction for more than 790,000 people and a theoretical reduction of 57 lung and bladder cancer cases per year in California (California Department of Public Health 2004).

Adequate operation and maintenance of the distribution system network will reduce delivery problems (main or tank ruptures, water outages) and ensure delivery of high quality water. In California, operators of drinking water distribution systems must be certified at the appropriate level depending on the size and complexity of the distribution system. This certification requirement helps to ensure a competent level of operation of distribution systems.

Similarly for water treatment facilities, proper operation and maintenance is essential for achieving optimum water treatment plant performance. In California, operators of drinking water treatment facilities must be certified at the appropriate level depending on the size and complexity of the treatment facilities.

Water fluoridation ranks as one of ten great public health achievements of the 20th century according to the U.S. Surgeon General in 2000. Fluoridation of public water supplies targets the group which would benefit the most from its addition, namely infants and children under 12, by decreasing cavities and improving dental health. Studies have shown unequivocally that fluoridation, at the optimal concentration, reduces the incidence of dental caries by 50-70 percent. It has also been demonstrated that carries will increase if water fluoridation is discontinued in a community for an extended period. One example is what happened in Antigo, Wisconsin. Antigo started fluoridating its community water supplies in 1949 and discontinued it in 1960. Five and one-half years later, second graders had more than 200 percent more tooth decay, fourth graders had 70 percent more, and sixth graders had 91 percent more tooth decay than children of the same age in 1960 (California Department of Public Health Community Water Fluoridation Program 2009).

Potential Costs

The cost of providing drinking water in compliance with all drinking water standards is steadily increasing due to increasing costs for energy and materials and increasing regulations requiring higher levels of treatment. Water bills reflect the costs of pumping, treating, and delivery of water as well as the operation and maintenance of the system, water quality testing, and debt repayment. Water treatment costs may include the cost of chemicals, energy, and operation and maintenance of the treatment facilities. Drinking water treatment costs will vary widely from plant to plant. Many different factors can affect the cost of water treatment, including the choice of which water treatment technology to use.

Table 15-4 summarizes the past and future estimated costs of treated full-service water provided by the Metropolitan Water District of Southern California (MWD), which treats a blend of surface water from the Colorado River and the California Aqueduct. The table shows an increase of approximately 65% from 2007 to 2012 in the cost to provide treated water in an area serving a large rate base. The additional cost reflects improvements to the treatment provided, increased cost for chemicals and energy, and reduced availability of new water supplies. The primary cost factors causing the rate increase included increased conservation efforts, the quagga mussel control program, litigation, and the higher cost for State Water Project deliveries. MWD may not capture the true cost of service with these rates and must cover some costs through the use of reserves.

PLACEHOLDER Table 15-4 Metropolitan Water District of Southern California Treated Water Rate History

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

The increase in cost to provide safe drinking water for smaller systems may be significantly greater on a per capita basis. These systems lack the economy of scale necessary to achieve savings in their day-to-day operations. In addition, most small systems have not set up any assets management plan or created a capital improvement account as a means to fund infrastructure replacement.

Per household costs for compliance with new regulations for small water systems can be more than four-fold higher than those for medium-to-large water systems (U.S. EPA 2006). Where substantial areas are impacted by contamination, such as the nitrate contamination in the Tulare Lake basin and Salinas Valley, the cost to consumers can be significant. According to a recent UC Davis study titled Addressing Nitrates in California's Drinking Water – Technical Report 7: Alternative Water Supply Options (Honeycutt K, Canada HE, Jenkins, MW, Lund JR 2012), about 2.4 million people receiving groundwater supplies from community water systems and state small water systems are potentially impacted by nitrate in the Tulare Lake basin and Salinas Valley study areas. In addition, about 245,490 persons in these areas obtain water from unregulated private water supplies that may also be subject to nitrate contamination. According to the UC Davis study, the estimated cost per person to provide safe water (water that meets nitrate standards) is estimated to be between $80 and $142 per year. For a typical public water system customer, this cost represents an estimated increase in the monthly water bill from $23 to $42/month based on $80 to $142/yr. x 3.5 persons per household.

The most prevalent groundwater contaminant is arsenic, a naturally occurring contaminant, affecting an estimated 287 community drinking water system statewide (State Water Resources Control Board 2012). The average annual cost per household to comply with the arsenic MCL is estimated to range from $140 to $1,870 per residence depending on the size of the water system (California Department of Public Health 2008b). These costs are in addition to current costs for drinking water.

Up to one-third of the operations and maintenance costs for some water utilities are energy related, including energy used for water treatment and pumping. One factor in water-related energy consumption is using new technologies that are more energy intensive than most previous treatment technologies e.g., UV treatment and high pressure membranes.

Desalination will play an increasing role in California's water supply, both for brackish groundwater desalination and seawater desalination. Historically, the high cost and energy requirements of desalination had confined its use to places where energy is inexpensive and freshwater is scarce. Recent advances in technology, especially improvements in membranes, have made desalination a realistic water supply option. The cost of desalinating seawater is now competitive with other alternatives in some locations and for some high-valued uses. However, although process costs have been reduced due to the newer membranes that allow for lower energy consumption, the total costs of desalination, including the costs of planning, permitting, and waste salt brine concentrate management remain relatively high, both in absolute terms and in comparison with the costs of other alternatives (National Resource Council 2008). Since development of other traditional sources of supply is limited and may require substantial capital investment, such as new storage or canal systems, the expanded development of brackish water and seawater desalination may become more cost competitive.

The condition of infrastructure is a growing concern in California and throughout the country. In the *Report Card for America's Infrastructure*, the American Society of Civil Engineers gave drinking water infrastructure across the country a D-minus. The U.S. EPA conducted a Drinking Water Infrastructure Needs Survey and Assessment in 1995, 1999, 2003, 2007, and 2011 (results are still being compiled by U.S. EPA). The 2007 survey shows a total investment need of $334.8 billion over the next 20 years nationwide. It identified a total investment need of $39.0 billion for California. This is more than 11 percent of the national need. The majority of the California need was for transmission and distribution systems (59%, or $22.98 billion). The second highest need category was for treatment (20%, or $7.5 billion), followed by water storage (15%, or $5.7 billion), and water source (6.4% or $2.5 billion) (All amounts are in January 2007 dollars). This does not include the infrastructure needs of tribal water systems that are regulated directly by U.S. EPA as tribal nations. See the following link for information about these systems: http://water.epa.gov/infrastructure/drinkingwater/dwns/upload/2009_03_26_needssurvey_2007_report_needssurvey_2007.pdf . California's investment needs may not include all cost associated with changes in the Colorado River water resources, recent or evolving drought issues, or changes to groundwater basins.

Funding for drinking water projects on tribal lands is provided by the federal government as part of the Drinking Water Infrastructure Grants: Tribal Set-aside Program, which was established by the federal Safe Drinking Water Act reauthorization of 1996. The program allows the U.S. EPA to award federal grants for infrastructure improvements for public drinking water systems that serve tribes.

Major Implementation Issues

Based on a review of issues discussed within the water supply industry and regulatory agencies, the following topics represent some of the most significant challenges for public water suppliers and the regulatory agencies today.

Deteriorating Infrastructure

With the aging of the nation's infrastructure and the growing investment needed to replace deteriorated facilities, the water industry has a significant challenge to sustain and advance its achievements in protecting public health and the environment (Grumbles 2007). During the last several decades, the public investment has been toward expanding and upgrading service levels, such as providing higher levels of treatment.

New solutions are needed for critical drinking water investments over the next two decades. Many utilities are moving to the concept of asset management to better manage and maintain their water facilities and infrastructure (Cromwell et al. 2007) for greater operational efficiency and effective use of limited funds. However, addressing the replacement of deteriorating infrastructure will add to the cost of water.

Asset management alone will not fix the basic problem. Particularly in smaller systems, inadequate funding for capital improvement plans for infrastructure replacement has created a serious problem. From the post-war period of the late 1940s and into the early 1980s, there was a proliferation of small community water systems located in rural areas and remote from the cities. In the past, such systems could often fund major maintenance and needed infrastructure replacement with informal assessments from the rate payers. However, the magnitude of the current infrastructure needs makes it very difficult to finance without creating an inordinate burden on rate payers.

CDPH has funding ‘set-asides’ from the Drinking Water State Revolving Fund (DWSRF) program to provide technical assistance to small water system operators and managers for technical, managerial, and financial areas. Additional funding would allow the expansion of this program into more detailed areas of asset management and rate setting.

Source Water Protection

There is an increasing need to protect source water quality as the first critical barrier in the multiple barrier approach to provide safe drinking water. A key issue is the increasing difficulty of protecting source water quality as the state population increases which results in increased wastewater discharge and urban runoff into surface water supplies. Another major issue is that some drinking water contaminants (organic carbon, nutrients, and pathogens such as *Giardia* and *Cryptosporidium*) are not currently regulated by the Regional Water Quality Control Boards in basin plans. Thus, there are generally no requirements for dischargers to control these contaminants.

Inadequate Financial Assistance to Address Both Water Treatment and Infrastructure Issues of Public Water Systems

The four major funding programs for California public water systems are DWSRF, Proposition 50, Proposition 84, and the American Recovery and Reinvestment Act of 2009 (ARRA). Combined, these programs have provided more than $1.87 billion to 441 public water systems to solve health risk problems and Safe Drinking Water Act violations, resulting in an overall risk reduction for consumers. However, this funding has not been adequate to address all of California’s identified needs. The combined project priority list for these funding programs includes more than 4,000 projects, many of which have been on the list since its inception in 1997 and have not received funding. The estimated value of unfunded need on the combined project priority list exceeds $12 billion is shown in Table 15-5.

PLACEHOLDER Table 15-5 California Department of Public Health Summary of Funded and Unfunded Projects

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

The CDPH Drinking Water Program administers multiple funding programs to assist water systems to achieve and maintain compliance with safe drinking water standards. These programs use federal funds and state funds to address the highest priorities of the total infrastructure need.

Safe Drinking Water State Revolving Fund

The largest funding program CDPH administers is the Safe Drinking Water State Revolving Fund (SDWSRF). The U.S. EPA provides SDWSRF funds to states in the form of annual Capitalization Grants. States, in turn, provide low interest rate loans and other assistance to public water systems for infrastructure improvements. In order to receive a federal SDWSRF Capitalization Grant, states must have statutory authority for the program and must provide a state match equal to 20 percent of each annual Capitalization Grant. Pursuant to state statutes (Health and Safety Code, Division 104, Part 12, Chapter 4.5 commencing with Section 116760, Safe Drinking Water State Revolving Fund Law of 1997), CDPH is authorized to receive the federal Capitalization Grants and administer the SDWSRF program in California. California's SDWSRF program began in 1998 and issued its first loans in 1999. California's current share of the national SDWSRF is 9.35% (see Table 15-6) and it is the highest allocation of all states.

PLACEHOLDER Table 15-6 California Safe Drinking Water State Revolving Fund: Capitalization Grants from the U.S. EPA

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Total SDWSRF funding provided to public water systems in executed loans and grants to date is more than $1.3 billion. Approximately 80 percent of these funds are distributed by CDPH as subsidized interest rate loans to public water systems serving disadvantaged communities. The remainder is distributed in the form of grants to disadvantaged communities. Water systems determined to serve a disadvantaged community receive a zero percent interest rate loan and may receive grant funding. Disadvantaged communities are communities with a median household income (MHI) less than or equal to 80% of the statewide MHI and may receive grant funding up to 80% of the project costs based on affordability criteria. Severely disadvantaged communities are communities with a MHI less than or equal to 60% of the statewide MHI and may receive grant funding up to 100% of the project costs based on affordability criteria.

The majority of the SDWSRF funding is subsidized, low interest rate and zero interest rate loans that typically have a 20-year repayment term. All loans are secured, however the security varies and is most often provided by user water rates, charges, and/or surcharges. As the outstanding loans are repaid, they generate a steady repayment stream that currently exceeds $40 million per year. In accordance with state and federal SDWSRF laws, the funds from the repayment stream are added to the SDWSRF fund and can be utilized in the same manner.

SDWSRF Funding Priority

In accordance with federal requirements and state law, CDPH establishes the priority for SDWSRF funding based on the risk to public health. Each pre-application submitted for funding is evaluated and if eligible for funding is assigned a category, based on the problem to be addressed. Highest categories are problems associated with bacteriological pathogens, followed by nitrate, and then other chemicals that exceed primary (health-based) drinking water standards.

After the appropriate funding category is determined, CDPH further prioritizes projects based on bonus points. Bonus points are used to rank projects within a category. The addition of bonus points will not move a project from one category to another. To the extent feasible, when a group of systems is invited to complete the application process for SDWSRF funding, all the systems within that category seeking funding that year are invited to apply. Bonus points are assigned based on affordability, consolidation, type of water system, and population.

CDPH factors in affordability by comparing the MHI of the community served by the proposed project to the statewide MHI level. Communities that are below the statewide average MHI level receive additional ranking consideration. This gives poorer communities a higher ranking within a category than communities with higher income levels.

For purposes of ranking projects within a category, any project that includes consolidation of separate existing water systems will receive additional ranking points. Consolidation ranking points support projects that will provide reliability, efficiency, and economy of scale that can be achieved with larger water systems while discouraging the proliferation of numerous separate small systems that have inherent inefficiencies and limitations.

The type of water system is considered in prioritizing because there is a relatively higher health risk associated with persons who drink the same water each day over a period of time, known as accumulated exposure. Thus, community and non-transient non-community water systems are ranked above transient non-community systems within a category and with the same bonus ranking points.

All projects within a category that have the same number of ranking points and are the same type of system are ranked in ascending order based on the population served by the water system. Smaller populations are ranked above higher populations.

CDPH combines all these factors to develop a Project Priority List (PPL) each year. CDPH then invites projects for funding from the PPL. Recently, Congress has required states to commit 20% of the SDWSRF funds to "green projects" such as water or energy efficiency, green infrastructure, or other environmentally innovative activities. CDPH has awarded a portion of the funding to install water meters in disadvantaged communities.

American Recovery and Reinvestment Act

The American Recovery and Reinvestment Act was signed by President Obama on February 17, 2009. ARRA allocated $2 billion nationally for safe drinking water infrastructure improvements. California's share of these funds is $159 million and is administered by CDPH through its existing SDWSRF program. The ARRA funds were a one-time opportunity and did not require state matching funds.

CDPH issued funding agreements totaling $149 million to 51 projects statewide. These 51 projects are distributed among 47 community drinking water systems. The funds were committed to drinking water infrastructure projects that were identified as "ready to proceed." All funding agreements were issued by

December 2009 and all projects were under construction by February 2010. The ARRA-funded projects are in different stages of construction and all must be completed by June 30, 2013.

Proposition 50

Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Water Code Section 79500, et seq.) was passed by California voters in the November 2002 general election. CDPH is responsible for portions of the Act that deal with water security, safe drinking water, and treatment technology. This approved bond measure allocated $485 million to CDPH to address drinking water quality issues in California. Proposition 50 authorizes up to 5 percent of the funding for CDPH to administer the funding programs listed below. In addition, 3.5 percent must be allocated for bond costs. Under Proposition 50, CDPH is also responsible for multiple funding programs described below.

Chapter 3, Water Security

Water Code Section 79520 provides $50 million to CDPH to protect state, local, and regional drinking water systems from terrorist attacks or deliberate acts of destruction or degradation. These funds may be used for

- Monitoring and early warning systems.
- Fencing.
- Protective structures.
- Contamination treatment facilities.
- Emergency interconnections.
- Communications systems.
- Other projects designed to
    - Prevent damage to water treatment, distribution, and supply facilities.
    - Prevent disruption of drinking water deliveries.
    - Protect drinking water supplies from intentional contamination.

CDPH developed criteria that prioritized Chapter 3 funding to water systems to construct emergency interties with adjacent water systems. Emergency intertie connections ensure there is an alternate connection to a water system if there is a disruption in water supplies during emergencies, such as natural catastrophes or terrorist attacks. This provides additional assurance of continuous water supplies to the largest populations.

Chapter 4, Safe Drinking Water

Water Code Section 79530 provides funding to CDPH for grants for public water system infrastructure improvements and related actions to achieve safe drinking water standards.

Section 79350(a) (Chapter 4a) provides $70 million for grants to small community water systems (less than or equal to 1,000 service connections or less than or equal to 3,300 persons) to upgrade monitoring, treatment, or distribution infrastructure. It also provides grants for community water quality monitoring equipment, drinking water source protection, and treatment facilities necessary to meet disinfection byproduct drinking water standards. CDPH developed criteria that prioritized Chapter 4a funding to water systems based on public health risk, using the SDWSRF categories as well as other criteria specific to the funding section. In addition, the criteria give priority to disadvantaged communities within each category.

Section 79350(b) (Chapter 4b) provides $260 million for grants to Southern California water agencies to assist in meeting California's commitment to reduce Colorado River water use to 4.4 million acre-feet per year. CDPH developed criteria that prioritized Chapter 4b funding to water systems in accordance with the bond language. Projects are assigned points based on three ranking criteria and a cumulative score is determined for each project. The projects are then ranked by that score from lowest to highest. Criterion 1 ranks projects by Proposition 50/AB 1747 categories and by water system population (from highest to lowest) within a category. Criterion 2 ranks projects by reduction of the annual volume of Colorado River water demand. Criterion 3 ranks projects by the cost per volume of the reduced demand.

Proposition 84

Proposition 84, the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Act of 2006 (Public Resources Code Section 75001, et seq.) was passed by California voters in the November 2006 general election. This approved bond measure allocated $300 million to CDPH to address drinking water and other water quality issues in California. Proposition 84 authorizes up to 5 percent of the funding for CDPH to administer the funding programs. In addition, 3.5 percent must be allocated for bond costs. Within Proposition 84, CDPH is responsible for multiple funding programs listed below.

- Section 75021 provides $10 million for grants and direct expenditures for emergency and urgent actions to ensure safe drinking water supplies. CDPH developed criteria to determine the eligibility of Emergency Grant projects. All requests that meet the eligibility criteria are funded until the funds are exhausted. Factors that CDPH considers include:
  - Type of contaminant(s).
  - Degree of contamination.
  - Whether the health hazard is acute (immediate) or chronic (long-term).
  - Length of time to which consumers have been or will be exposed.
  - Any actual or suspected illnesses.
  - Any actions taken by the local Health Officer or the local Director of Environmental Health.
  - Other funds to resolve the public health threat or emergency.
  - Duration and extent of a water outage due to an emergency.
  - Duration and extent of loss of power due to an emergency.
- Section 75022 provides $180 million in grants for small community drinking water system infrastructure improvements for chemical and nitrate contaminants and related actions to meet safe drinking water standards. $7.5 million is allocated, pursuant to 2011-2012 Budget Act, to projects in the City of Santa Ana and the City of Maywood.

  CDPH developed criteria that prioritize eligible projects in accordance with the bond language and subsequent legislation. Projects were scored by points based on:
  - Regulatory status of the principal contaminant to be addressed.
  - Health risk associated with the principal contaminant to be addressed.
  - Number of contaminants in the project's drinking water supply that exceed a primary drinking water standard.
  - Median household income of the applicant water system.

    - Project includes consolidation.
    - Project is part of a regional project.
- Section 75025 provides $60 million for immediate projects needed to protect public health by preventing or reducing the contamination of groundwater that serves as a major source of drinking water for a community. $2 million of the funding is allocated, pursuant to SB X2 1, to the State Water Resources Control Board to develop pilot projects in the Tulare Lake basin and the Salinas Valley that focus on nitrate contamination.

CDPH developed criteria that prioritize eligible projects in accordance with the bond language and subsequent legislation. Projects were scored by points which are based on the regulatory status of the principal contaminant to be addressed; the health risk associated with the principal contaminant to be addressed; the number of contaminants in the project's drinking water supply that exceed a primary drinking water standard; the median household income of the applicant water system; whether the project includes consolidation; and whether the proposed project is part of a regional project.

Regionalization/Consolidation

One way to improve the economy of scale, which results in the potential for many benefits including lower costs, is to increase regionalization of water supply systems. This can be achieved by physical interconnections between water systems or managerial coordination among utilities. CDPH has established a requirement for evaluating consolidation as part of every project funded under the available financial assistance programs. To address deteriorating infrastructure successfully for the hundreds of smaller public water systems in California, regionalization and consolidation may be necessary on a larger scale. It is not cost-effective for a small system to replace aging and deteriorated sources, treatment plants, and distribution systems fully. However, with a larger rate base to spread costs across, the economies of scale improve for consolidated systems. Managerial consolidation of water districts, even where the boundaries are not contiguous, can provide great savings to the consumers by sharing the costs of oversight and management of the systems, thus freeing up funds for system upgrades. Box 15-1 describes a regional consolidation project in the planning stages.

PLACEHOLDER Box 15-1 Rosamond Community Services District Regional Consolidation Project

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Disadvantaged Communities/Environmental Justice

There has been heightened interest in environmental justice issues as a result of nitrate contamination problems in public water systems, particularly those in agricultural areas such as the Central Valley. It is the role of the federal government to ensure that, in the development and implementation of new regulations, disadvantaged communities are protected at levels afforded to other demographic communities. Presidential Executive Order 12898 establishes a federal policy for incorporating environmental justice into federal agencies' missions by directing them to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

Each of the three major water system funding programs implemented by CDPH provides some special financing for water systems that serve areas with relatively low median household income. For example, the SDWSRF can provide grant funds and zero-interest loans to water systems serving a community with a low MHI as stated earlier. Proposition 50 funding has a target goal to provide 25 percent of the funding to low-MHI communities. A significant portion of the Proposition 84 funds allocated to drinking water are specifically targeted at small disadvantaged communities with contamination problems. Funding from both Propositions 50 and 84 is limited due to the one-time allocation specified for drinking water.

Impact of Climate Change

Climate change projections include warmer air temperatures, diminishing snowpack, precipitation extremes and storm intensity, prolonged droughts, and sea level rise. These anticipated changes could affect water quality in regions that are already experiencing difficulty meeting current water demands.

Earlier snowmelt and more intense episodes of precipitation with increased flood peaks may lead to more erosion, resulting in increased turbidity and concentrated pulses of pollutants in source waters. Increased flooding may lead to sewage overflows, resulting in higher pathogen loading in source waters. These potential changes could result in challenges for surface water treatment plants and may require additional monitoring to quantify changes in source water quality and to meet post-treatment drinking water standards.

Increased water temperatures and reduced reservoir levels may result in more prevalent eutrophic conditions, increasing the frequency and duration of algal blooms. Higher water temperatures can also accelerate some biological and chemical processes, such as increasing growth of algae and microorganisms, depletion of dissolved oxygen, and various impacts to water treatment processes. Higher sea levels as a result of climate change could impact coastal groundwater basins by making protection of groundwater from seawater intrusion more difficult.

Adaptation

Increasing demand on limited and valuable water resources available in California will compound any climate change impact. The continued growth in the state will continue to stress the availability of the freshwater resources needed for domestic, agricultural, and industrial uses. California coastal water providers have begun evaluating and employing desalination of seawater as an additional drinking water supply. Desalinated seawater, although more expensive to develop due to the high energy requirements and planning and permitting costs, has been identified as a reliable drought-proof supply.

Regionalization of water supply systems as an adaptation strategy will also help counter the effects of climate change by adding operational flexibility during periods of drought or flooding. Investments in drinking water facilities and conveyance systems will add efficiency and lead to enhanced sustainability in the future. Adaptation to climate change to provide adequate drinking water will likely require specific regional strategies described in this chapter that focus on conservation, sustainability, and operational flexibility.

Mitigation

Demand for drinking water treatment and distribution will continue to increase as climate change has major impacts on water quality and availability of the freshwater resources used for drinking water.

Adverse impacts on climate change related to increasing greenhouse gas emissions could result from energy uses in 1) drinking water treatment and distribution systems, 2) bottled water production including related transportation and waste disposal, and 3) treatment of new sources of drinking water from low quality groundwater and recycled wastewater. However, improving water and energy efficiency from management strategies described in this chapter could have benefits that reduce energy uses and greenhouse gas emissions as part of climate change mitigation including:

- Promoting opportunities to use more tap water and less bottled water to reduce related energy and greenhouse gas emissions.
- Conducting audits for water and energy efficiency in drinking water treatment and distribution systems.
- Providing operational efficiency and improving aging infrastructure to control water losses for water and energy saving.
- Developing programs and applying new technologies to reduce energy use in both water treatment plants and for new sources of drinking water such as low quality groundwater and recycled wastewater.
- Developing energy efficiency standards for drinking water treatment and distribution systems.
- Coordinating with water use efficiency programs and using best management practices to save water and energy such as utility leak detection, water conservation, and water efficiency pricing and incentives for installing water efficient appliances and landscaping.

Water Use Efficiency

The efficient use of water is regarded as a viable complement, and in some instances a substitute, to investments in long-term water supplies and infrastructure. Water use efficiency is a concept to maximize the use of water or minimize its waste. Water use efficiency will continue to be a key element of addressing reduced water availability and is regarded as a major step to take before turning to more costly water sources such as desalinated seawater. Water efficiency programs and practices may include utility leak detection, water conservation programs, water efficiency pricing and incentives for installing water efficient appliances and landscaping, as well as improvements in water recovery as part of water treatment plants (e.g., recycling water used in treatment plant processes for backwash).

An important aspect of strongly encouraging water conservation is the ability of the water utility to establish an escalating metered rate based on the volume of water used. This promotes full cost recovery, conservation, or efficiency pricing. Since 1992, California law has required urban water suppliers (those serving more than 3,000 connections or delivering more than 3,000 af of water per year) to install a water meter on new connections. More recently, AB 2572 established the requirement for retrofitting water meters on pre-existing connections and charging customers for water based on the actual volume of water used. Neither of these laws addresses smaller water systems that do not meet the definition of an urban water supplier.

However, many larger water agencies have already taken advantage of conservation programs to reduce the need for new water supplies. The Los Angeles Department of Water and Power (LADWP) has shown success in conservation where water use today is the same as it was 25 years ago, despite a population increase of nearly 1 million people (City of Los Angeles Department of Water and Power 2008). Obtaining additional conservation increases will be more difficult and may result in higher costs to achieve.

To address water losses or unaccounted water, water utilities conduct audits to identify water main leaks, unmetered water use for parks and recreation consumption, water theft, and inaccurate meters. Deteriorated and aging infrastructure can play an important role in water losses which contributes to significant water leakage and a high rate of water main breaks. Nationally, there has been reported water losses by utilities of between 10% to nearly 50% of the water produced. Due to the continued aging of distribution infrastructures that are at or near the end of their useful life, water losses due to water main leaks can be expected to remain a significant and potentially increasing barrier to California's efforts to conserve water. Both the Safe Drinking Water State Revolving Fund program and the American Recover and Reinvestment Act administered by CDPH, provide funding to drinking water systems for water meter installation. Water meters are an important tool to measure water loses in the distribution system.

Maintaining a Trained Workforce

California requires operators of water treatment plants and distribution systems to receive certification to perform these duties. This certification is designed to ensure that operators have adequate knowledge, experience, and training to operate these facilities properly. Due to the increased complexity of water system facilities, the importance of properly trained and certified operators is increasing.

Sustaining a trained workforce to maintain an adequate level of qualified oversight at water treatment plants and operation of distribution systems has been identified as an important issue. This is, in part, due to the increased number of people from the large Baby Boomer generation beginning to leave the workforce. CDPH data indicate that the average age of operators certified in California is about 50, and the average age of Grade 5 treatment plant operators (the highest treatment certification available) is greater than 55 (Jordan 2006). Many water utilities will lose 30 to 50 percent of their current workforce within the next 5 to 7 years, which will result in an unprecedented knowledge drain. A knowledge retention strategy is necessary to ensure long-term success.

Knowledge retention, broadly termed succession planning, is the process of identifying and preparing suitable employees through mentoring, training, and job rotation to replace key staff, such as treatment or utility managers, within an organization as current managers retire. Succession planning will become more important in the near future to ensure the transfer of knowledge as less experienced staff moves into higher decision-making positions. This issue applies to both the public and private water sector, as well as to the government agencies that regulate the water industry. Graduating engineering students show a noticeable lack of interest in the water industry.

In November 2006, CDPH introduced the Expense Reimbursement Grant Program (ERG) for small water system operators using a U.S. EPA grant. ERG provided funding for small water system operators to receive reimbursement for training to become certified operators or to maintain and advance their operator certification levels. This program provided training reimbursement for operators until all funding was expended in early 2011.

Treatment Technologies for Small Water Systems

Providing safe and affordable drinking water is still a significant challenge for small water systems. Economies of scale typically become more limited for the small system size categories, resulting in per-household costs for compliance with new regulations that can be more than four times higher than those for medium-to-large water systems (U.S. EPA 2006). There have been advances in the effective use of point-of-use (POU) and point-of-entry (POE) technologies for certain contaminants under controlled circumstances for some small drinking water systems (Cadmus Group 2006). POU devices are those that treat water at the location where it is consumed, such as at the tap or a drinking fountain. POE devices are those that treat all of the water entering a home or building, not just water that is consumed. POE technologies treat all water that a consumer comes in contact with, such as bathing and handwashing, while a POU device provides treated water at one tap intended for drinking and cooking and is usually installed in the kitchen. The California SDWA allows the consideration and approval of POE for compliance with drinking water standards where it can be demonstrated that centralized treatment at the wellhead or surface water intake is not economically feasible. The California SDWA also allows the consideration of POU devices as per the above and provided they also demonstrate that the use of POE devices is either not economically feasible or POE devices would not be as protective of public health as POU devices. Specifically, only systems serving less than 200 connections may be eligible to use POU or POE devices and they must first demonstrate: 1) that the installation of centralized treatment is not immediately economically feasible, 2) that usage of the POE or POU device is allowed under the Federal Safe Drinking Water Act for the specific contaminant, and 3) that the water system has submitted a pre-application for funding to correct the violation for the contaminant that the POE or POU device is proposed to treat.

New treatment technologies that are cost-effective and do not require extensive operator attention are often needed to address chemical contaminants that affect small water systems. Proposition 50 provided funding to demonstrate some of these technologies. As new technologies are proposed to treat water to drinking water standards, CDPH must review and approve these technologies and use staff dedicated to reviewing these technical aspects of drinking water treatment.

Treatment Residuals Disposal

In many areas, treatment options for contaminants are limited due to residual disposal issues. For example, the disposal of brine from ion exchange and reverse osmosis treatment has been identified as a potential source of salinity in groundwater. California, and especially the central San Joaquin Valley, is experiencing increased salts in the groundwater. As the salinity of local groundwater sources increase, more water customers use water softeners to improve the quality at their tap. This, in turn, results in a higher discharge of salts to the wastewater treatment plants which increases the salinity of wastewater and exacerbates the problem. The Central Valley Regional Water Quality Control Board completed a study in May 2006 on salinity in groundwater in the Central Valley which introduced the concept of a long-term salinity management program for the Central Valley and for California (Central Valley Regional Water Quality Control Board 2006). Additional information is available in Chapter 19, Salt and Salinity Management.

Disposal of residuals, such as backwash water or spent media, poses additional costs for water treatment, especially those that may be classified as a hazardous or radioactive waste due to the concentration and leaching characteristics of the contaminant. Selection of treatment alternatives, especially for arsenic, must consider disposal issues. The spent treatment plant media must be evaluated under the California Waste Extraction Test (WET) for classification prior to determining appropriate disposal options due to the potential for the arsenic to leach from the media in a landfill environment. The California WET classification is more stringent than federal leaching tests. The City of Glendale water system conducted a study that evaluated treatment alternatives for removal of chromium-6 that included disposal of treatment residuals. See Box 15-2 for additional information.

PLACEHOLDER Box 15-2 City of Glendale Chromium-6 Treatment Residuals Disposal Study

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Security of Drinking Water Facilities

Water system facilities are vulnerable to security breaches, acts of terrorism, and natural disasters (all-hazards). Both water system personnel and the general public have developed a greater awareness of the vulnerability of California's critical infrastructure and key resources because of the events of September 11, 2001, Hurricane Katrina in 2005, and many other disasters and incidents since then. The enhancement of security and emergency response and recovery capabilities are crucial to maintain a reliable and adequate supply and delivery of safe, clean, and wholesome drinking water. Just as crucial are forming, developing, and exercising relationships with partners and stakeholders.

Under the U.S. Public Health Security and Bioterrorism Preparedness and Response Act of 2002, drinking water utilities serving more than 3,300 people were required to conduct Vulnerability Assessments and develop/update their Emergency Response Plans to address these vulnerabilities. All of California's water utilities in this category have prepared these documents. These documents and their implementation are an important element in building and maintaining the ability to respond to security breaches and other catastrophes and to recover from them.

The accomplishments by the water industry, the wastewater industry, and regulatory agencies to protect California's water and wastewater facilities from all-hazards include:

- Emergency Water Quality Sample Kit (EWQSK) developed by CDPH and based on the U.S. EPA Response Protocol Toolbox. These sample kits provide water systems with a resource to sample drinking water quickly for an unknown contaminant during a credible event.
- Partnerships between water agencies and the regulatory community were established to address emergency response and recovery, including the California Water/Wastewater Agency Response Network (CalWARN), Laboratory Response Network (LRN), and the California Mutual Aid Laboratory Network (CAMAL Net). WARN systems facilitate a utilities-helping-utilities approach by providing assistance during a crisis. By establishing mutual aid agreements before a crisis occurs, WARN participants pave the way for member utilities within and outside of their respective regions to send valuable aid in a quick and efficient manner. WARN participants can access specialized resources to assess and assist water and wastewater systems until such time as the system can develop a permanent operating solution.
- Water Infrastructure Security Enhancement (WISE) Guidelines, drafted for the Physical Security of Water/Wastewater Utilities by national water and wastewater organizations, provide recommendations for the management, operation, construction, and retrofit of water and wastewater treatment plants and distribution/collection systems to enhance physical security. The WISE Guidelines are at http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Security.aspx.
- Coordination among partners and stakeholders and developing those relationships are critical to a successful response and recovery, and to improving situational and operational awareness. The water and wastewater communities and respective regulatory organizations

have formed many groups to accomplish this critical network that meet periodically and communicate regularly. These groups include:
  - InfraGard that was created and sponsored by the Federal Bureau of Investigation as a public/private information sharing and analysis collaborative. It was established since the majority of critical infrastructures and key resources are owned and operated by private entities.
  - Local Terrorism Early Warning Groups (TEWG) that meet to exchange information and discuss local and national issues.
  - Water ISAC, a Department of Homeland Security- recognized center, that provides water and wastewater information sharing and analysis.
- Recognizing that communication during a crisis can make or break a successful response, the CDPH used the Centers for Disease Control and Prevention Crisis and Emergency Risk Communication (CERC) Toolkit and modified it specifically for the water and wastewater community. CDPH has conducted numerous CERC training classes detailing the toolkit and espousing the virtues of being prepared to address risk communication during a crisis.
- A successful response and recovery is also strongly dependent upon exercising the policies, procedures, processes, and partnerships. To that goal, the regulatory communities are providing training to the water and wastewater communities on designing and conducting tabletop exercises. Tabletop exercises are a low cost, low stress process by which partners can work together on scenarios and discover any gaps or gains. This is further strengthened by the nationwide acceptance, training, and use of the Department of Homeland Security, Homeland Security Exercise and Evaluation Program (HSEEP) which provides a nationwide framework for exercises and improvement.
- Numerous tools have been created to help water and wastewater utilities be better prepared for crises and emergencies. These include:
  - Water Health and Economic Analysis Tool (WHEAT), that is a consequence analysis tool designed to assist drinking water and wastewater utility owners and operators in quantifying human health and economic consequences for a variety of scenarios that pose a significant risk to the water sector.
  - Vulnerability Self-Assessment Tool (VSAT), that is a risk assessment software tool for water, wastewater, and combined utilities to assist drinking water and wastewater owners and operators to conduct security threats and natural hazards risk assessment as well as updating utility Emergency Response Plans.
  - FedFUNDS, that is a new interactive Web site created to help water and wastewater utilities navigate through the maze of Federal Disaster Funding. See http://water.epa.gov/infrastructure/watersecurity/funding/fedfunds/index.cfm.

Existing and Emerging Contaminants

New contaminants in drinking water are often discovered and then regulated because of increased pollution, improved analytical abilities, and/or a better understanding of health effects. Media attention to a particular contaminant has also resulted in a legislative response to address or speed up the regulatory process. Examples include hexavalent chromium, pharmaceuticals, and personal care products. In addition, the health effects of many known contaminants are re-evaluated and re-regulated as new information becomes available. For many emerging contaminants, such as pharmaceuticals and personal care products, there may not yet be a full understanding of the health risks they cause in drinking water and available treatment technologies to remove them from drinking water. For such contaminants, the pollution prevention and matching water quality to water use resource management strategies will help address water quality concerns while additional information is gathered. For pharmaceuticals and personal care products control of discharge to the environment is the best initial approach, via source control programs and reduction through wastewater treatment, rather than relying on drinking water treatment.

Emerging contaminants may be created by treatment itself, for instance, when water utilities implement new methods or processes for disinfecting water that may create new disinfection byproducts. For some contaminants, treatment options may be available, but they may be relatively expensive.

Recommendations

Because of the importance of drinking water, there is strong interest from many groups to promote improvements to drinking water treatment and distribution facilities, operation, and management. These groups include:

- Water system managers and operators.
- Local governmental agencies—city, county, planning.
- Regulatory agencies such as CDPH, local primacy agencies (county-level), and the U.S. EPA.
- Environmental and community stakeholders.

Based on the major issues outlined in this chapter, the following additional actions are needed to ensure there is adequate protection of public health through the maintenance of infrastructure, advancements in water treatment, and developing and maintaining relationships among the groups that advocate safe drinking water:

1. The Legislature should take necessary steps to maintain a sustainable source of funding of water supply, water treatment, and infrastructure projects to ensure a safe and reliable supply of drinking water for individuals and communities and to provide state matching funds for federal Safe Drinking Water State Revolving Fund monies.
2. Additional funding should be provided to CDPH to provide increased technical assistance to small water systems related to asset management and rate setting.
3. The Legislature should take steps to require publicly owned water systems to establish water rate structures at a level necessary to provide safe water, replace critical infrastructure, and repay financing for treatment and distribution system improvements necessary to meet drinking water standards.
4. State government should support enactment of a federal water infrastructure trust fund act that would provide a reliable source of federal assistance to construct and repair water treatment plants.
5. Additional programs should be developed to encourage regionalization and consolidation of public water systems. Regionalization and consolidation are useful both in achieving compliance with water quality standards and in providing an adequate economy of scale for operating and maintaining existing facilities as well as planning for future needs.
6. State government should continue to develop funding for small water systems and disadvantaged communities to assist in complying with drinking water standards.
7. State government should continue to encourage conservation and develop additional incentives, such as expanded rebate programs, to allow water systems to reduce the waste of limited water resources.

8. Public water systems that provide flat rate water service should strongly consider changing to a metered water rate structure to discourage waste. In addition, water systems that have water meters for some customers but not on all service connections should strongly consider providing water meters for all customers.
9. State government should consider providing incentives that would encourage water systems to adopt rate structures that encourage conservation and discourage the waste of water.
10. The Legislature should establish a requirement for all public water systems, whether in urban or other areas of the state, to install a meter on each service connection and charge a metered rate for actual volume of water used.
11. California's regulatory agencies, such as the State Water Resources Control Board and California Department of Public Health, should maintain internship programs for college students to continue the interest of the next generation in water and environmental regulatory agencies.
12. State government should support research and development of new and innovative treatment technologies by providing funding for demonstration pilot projects. Additional program funding is also needed by CDPH to address the review and acceptance of these new treatment technologies adequately .
13. Water systems should fully evaluate residual disposal issues when planning new water treatment facilities due to increased costs and other issues associated with disposing treatment residual wastes.
14. All public water systems should be encouraged to join the California Water/Wastewater Agency Response Network. This program will provide mutual aid and assistance more quickly than the normal resource requests submitted through the Standardized Emergency Management System.
15. The control of pharmaceuticals and personal care products in the environment should be addressed initially via source control programs and reduction through wastewater treatment

Drinking Water Treatment and Distribution in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions aren't consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy isn't discussed in the rest of Update 2013), there is no need for this section to appear.]

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Table 15-1 Public Water Systems in California by Class

Public Water System Classification	Number
Community	2,973
Nontransient noncommunity	1,490
Transient noncommunity	3,111
Total number of public water systems	7,574

Source: California Dept. of Public Health records, August 2012. Does not include water systems serving Native American Tribes or on tribal lands.

Table 15-2 Number and Type of CPUC-Regulated Water Agencies

CPUC class	Number of Connections Served	Number of Agencies in Class
A	>10,000	10 [a]
B	2,000-10,000	6 [a]
C	500-2,000	22
D	<500	85

Source: California Public Utilities Commission web site, June 2012.

[a] Many of the private agencies included in the number shown operate multiple water systems throughout California

Table 15-3 Treatment Plants on California Public Water System Sources

Type of Contaminant	Approximate Number of Major Treatment Plants
Surface water [a]	699
Nitrate	150 [b]
Arsenic	79 [b]
Perchlorate	40
Radiological	10 [b]
Volatile and synthetic organic chemicals	220 [b]
Aesthetic water quality	350

Source: These estimates are based on a survey of California Dept. of Public Health offices and from California Dept. of Public Health records.

[a] Surface water, defined under the California Surface Water Treatment Rule (Cal. Code Regs., tit. 22, § 64651.83.) means "all water open to the atmosphere and subject to surface runoff..." and hence would include all lakes, rivers, streams, and other water bodies. Surface water includes all groundwater sources that are deemed to be under the influence of surface water (i.e., springs, shallow wells, wells close to rivers), which must comply with the same level of treatment as surface water.

[b] Includes only chemical removal treatment facilities. Blending facilities are not included.

Table 15-4 Metropolitan Water District of Southern California Treated Water Rate History

Year	Cost of Treated Water ($/af)	
Historical and Current Water Rates		
1994	412	
1995-1996	426	
1997-2002	431	
	Tier 1 [a]	**Tier 2 [b]**
2003	408	489
2004	418	499
2005	443	524
2006	453	549
2007	478	574
2008	508	606
2009	579	695
2010	701	811
2011	744	869
2012	794	920
Projected Future Water Rates		
2013	847	997
2014	890	1032

Source: Metropolitan Water District of Southern California 2012.

[a] Tier 1 supply rate – recovers the cost of maintaining a reliable amount of supply.

[b] Tier 2 supply rate – set at Metropolitan Water District cost of developing additional supply and to encourage efficient use of local resources.

Table 15-5 California Department of Public Health Summary of Funded and Unfunded Projects

	Funded Projects		Unfunded Projects
Funding Source	Number of Systems	Funded Amount (million $)	Unfunded Need (million $)
SDWSRF	224	1,351	[a] 11,700
ARRA	51	150	
Proposition 50	78	295	366
Proposition 84	88	81	174
TOTAL	441	1,877	12,240

Source: California Department of Public Health 2012.

[a] ARRA used the SDWSRF project priority list for funding.

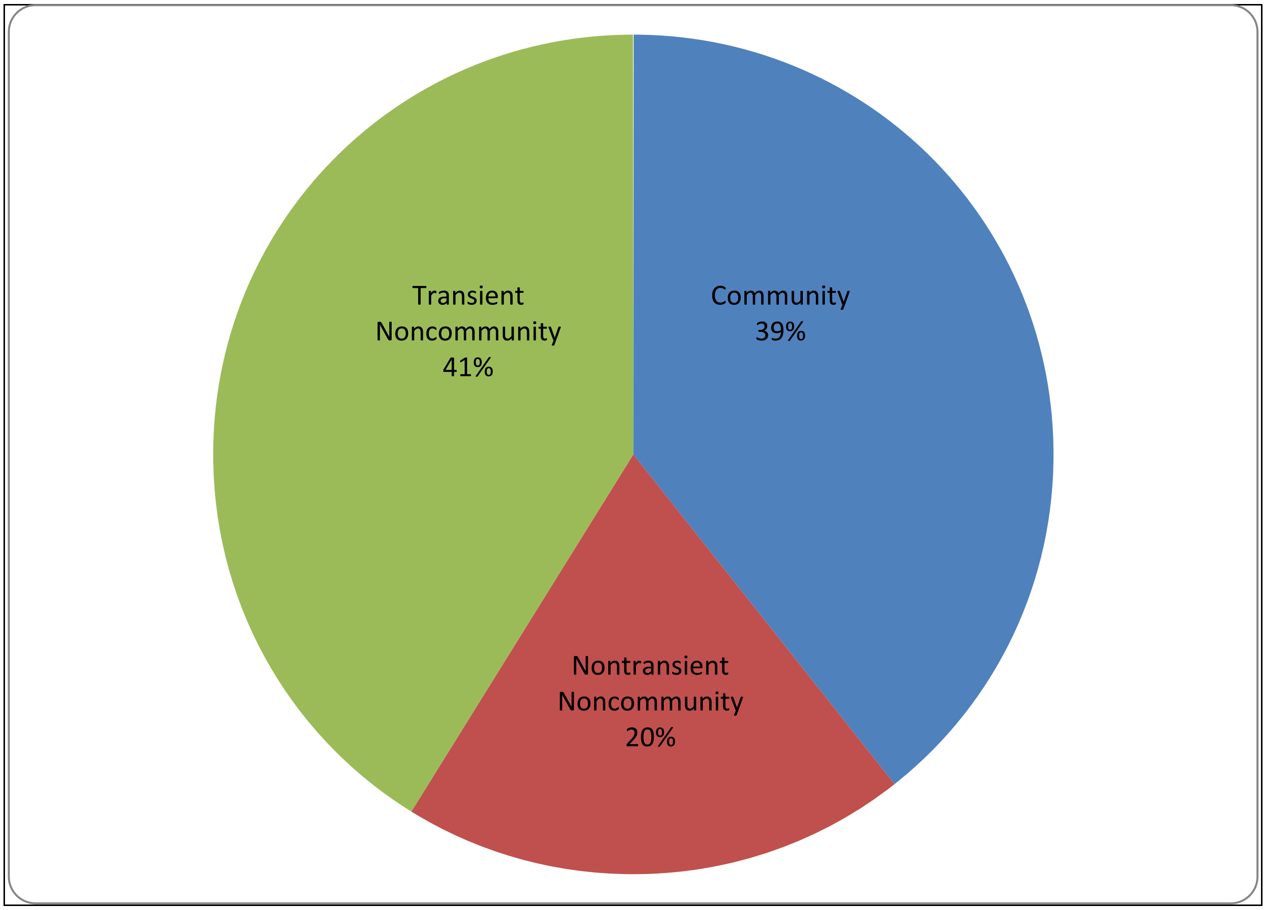
Table 15-6 California Safe Drinking Water State Revolving Fund: Capitalization Grants from the U.S. EPA

Fiscal Year	DWSRF Grant (million $)	% of National DWSRF Funds
1997	75.68	—
1998	77.11	10.83% (FY1998-2001)
1999	80.82	—
2000	83.99	—
2001	84.34	—
2002	82.46	10.24% (FY2002-2005)
2003	81.97	—
2004	85.03	—
2005	84.85	—
2006	67.10	8.15% (FY2006-2009)
2007	67.10	—
2008	66.4	—
2009 SDWSRF	66.4	8.15%
2009 ARRA [a]	159.0	8.15%
2010	137.32	9.35% (FY2010-2013)

Source: U.S. EPA Drinking Water Needs Survey 2009 and the Federal Register. See link for more information on DWSRF state allotments: (http://water.epa.gov/grants_funding/dwsrf/allotments/).

[a] In 2009, California Department of Public Health also received funding under the American Recovery and Reinvestment Act (ARRA) that essentially followed Safe Drinking Water State Revolving Fund (SDWSRF) funding rules.

Figure 15-1 Public Water System Class by Percent of Systems



Box 15-1 Rosamond Community Services District Regional Consolidation Project

The Rosamond Community Services District (CSD) Regional Consolidation Project is currently in the feasibility and planning stage to solve water quality problems of nine small water systems (one high school, four mutual water companies, one apartment complex, and three mobile home parks) in the Rosamond area. Eight systems have arsenic MCL violations and one system has a uranium MCL violation. Funding for this regional consolidation project will be through a combination of SDWSRF and Proposition 84 funding.

The ultimate plan will physically consolidate eight water systems with Rosamond CSD by using a combination of pipelines, storage tanks, and booster pumps. By consolidating the small water systems with Rosamond CSD, the customers of these small systems will receive water that meets drinking water quality standards and avoid installing treatment equipment which is very expensive to operate and maintain and may be unaffordable.

One mutual water company, which is farther away from Rosamond CSD and is currently under a court-ordered receivership with Rosamond CSD being the court appointed receiver, may need to install arsenic removal treatment equipment depending upon its affordability. This project will explore managerial consolidation of this mutual water company with the Rosamond CSD, in an effort to improve the economy of scale for this project and to improve operational reliability of any treatment installed.

It is anticipated that Rosamond CSD will request construction funding for the project following completion of the feasibility and planning studies.

Box 15-2 City of Glendale Chromium-6 Treatment Residuals Disposal Study

The City of Glendale completed a study comparing the treatment residuals waste produced by two treatment processes for removing chromium-6: a weak-based anion exchange (WBA) process and a reduction/coagulation process that removes chromium-6 through filtration (RCF).

The main waste in the WBA treatment process is spent ion exchange resin. Based on results of the federal Toxicity Characterization Leaching Procedure (TCLP) and the California Waste Extraction Test (WET), the waste resin is classified as a California-regulated non-RCRA waste and requires special handling and disposal. Additional waste characterization is needed due to the detectable quantities of uranium and thorium in Glendale's source water. While these contaminants are in the source water at concentrations below the maximum contamination levels (MCL), they are removed in the treatment process and concentrated in the resin. Testing was also conducted to determine whether the waste resin would be classified as a Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) or a Low-level Radioactive Waste (LLRW). Findings indicated that waste resin would not be classified as TENORM as long as the waste resin could be taken out of service prior to reaching uranium concentrations of 0.05% by weight, where it would require even more expensive disposal and handling as a LLRW.

The wastes from the RCF process are mostly settled solids after thickening and dewatering. The solids from the RCF process are classified as California-regulated non-RCRA waste and they are not classified as either a TENORM or a LLRW since the RCF process does not remove or concentrate appreciable quantities of uranium.

The disposal of treatment waste streams in California adds a major cost component to the cost of treating drinking water. Rather than disposal at a local landfill or other approved land disposal option, spent resin or solids must receive special handling and be sent to special disposal facilities that accept hazardous and/or radioactive materials.

Chapter 17. Matching Water Quality to Use — Table of Contents

Chapter 17. Matching Water Quality to Use

Matching water quality to use is a management strategy that recognizes that not all water uses require the same water quality. One common measure of water quality is its suitability for an intended use; a water quality constituent often is only considered a contaminant when that constituent adversely affects the intended use of the water. High quality water sources can be used for drinking and industrial purposes that benefit from higher quality water and lesser quality water can be adequate for some uses. For example, a water supplier chooses to use a groundwater source for municipal use, which requires less treatment before delivery, rather than a natural stream. The potential benefit to the municipal user could be reduced disinfection byproducts in the delivered drinking water source and a secondary benefit would accrue to the natural riparian system because water would be left instream. Further, some new water supplies, such as recycled water, can be treated to a wide range of purities that can be matched to different uses. The use of other water sources, like recycled water, can serve as a new source of water that substitutes for uses not requiring potable water quality. Instream uses are directly influenced by discharges from wastewater treatment and stormwater flows and these source discharges can provide benefits and challenges to uses such as aquatic life and recreation.

Matching Water Quality to Use in California

As part of the nine Regional Water Quality Control Boards Basin Planning efforts, up to 25 water quality beneficial use categories for water have been identified for mostly human and instream uses (see Definition of Beneficial Use for Water Quality and Water Rights in the glossary in Volume 4, Reference Guide). For this strategy, the beneficial uses discussed are primarily water quality-related beneficial uses. A second definition of beneficial uses of water is also defined by the California Code of Regulations for the purposes of applying for a water right to appropriate water. These two definitions of beneficial uses overlap, but differ enough so that one needs to be aware of the distinction (see California Code of Regulations, Title. 23, Sections 659-672).

Human uses are categorized as consumptive (e.g., municipal, agricultural, and industrial supplies) and non-consumptive (e.g., navigation, hydropower generation, and recreation). Instream uses include aquatic ecosystem uses, fish migration, spawning, and preservation of rare, threatened, and endangered species. Matching water quality to most of these uses is important because water is generally used as is i.e., without treatment except for municipal and industrial uses. In addition, aquatic organisms are more sensitive to some pollutants than humans. For example, the presence of dissolved metals at low concentrations can be lethal to sensitive fish species.

Matching Water Quality to Agricultural Use

Farmers currently match crops to the available water quality. In general, irrigation water should contain levels of constituents, such as salinity and boron, which will not inhibit the yields of some of the crops. Conversely, agricultural water supplies that have low levels of salts may require adding gypsum to improve percolation. Agricultural water supplies may require filtration to remove particulate matter that could clog low pressure irrigation systems and reduce soil infiltration rates. As an extreme case, Imperial Irrigation District runs all water that it diverts from the Colorado River at Imperial Dam through siltation basins to remove suspended particulates before the water is released into the All American Canal. In setting objectives for the reasonable protection of agricultural use in the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, the Regional Water Quality Control Board examined the suitability of soils to determine anticipated crop types and set the salinity objectives to meet the needs of these crop types.

Matching Water Quality to Instream and Ecosystem Use

Ambient, instream water must be suitable to support a wide range of aquatic habitats and conditions. Thus, water quality for instream uses generally must meet physical, chemical, and biological objectives specific to the habitat and instream needs. One particular water quality objective that greatly affects fisheries is temperature. An example of an effort made to match water quality to an environmental use for temperature is the Temperature Control Device at Shasta Dam, which was built to make a better match of water temperature to the reproductive needs of salmonid fish downstream. When viewed from a watershed level, decisions about whether to use instream versus out-of-stream sources, such as groundwater and recycled water, to meet future municipal and agricultural demands may result in the decision to leave water instream in favor of using out-of-stream alternatives.

Matching Water Quality to Drinking Water Use

In order to avoid the additional cost of treatment and to provide multiple protection barriers for public health, it is best that drinking water supplies start with the highest quality source water reasonably possible. Historically, California's urban coastal communities—Los Angeles, San Francisco, Oakland, and Berkeley—constructed major aqueducts to sources such as Hetch Hetchy, Owens Valley, and the Mokelumne River. Later, water supplies of lesser quality, such as the Sacramento-San Joaquin Delta and the Colorado River, were also tapped for domestic water supplies. In response, many utilities already manage water quality by blending higher quality water supplies with those of lower quality, as well as matching treatment process to source water quality, as required by regulation. For example, Metropolitan Water District of Southern California (MWD) dilutes high salinity Colorado River water with lower salinity water from the Sacramento-San Joaquin Delta (Delta). This improves the public's acceptance of tap water, as well as facilitating groundwater recharge and wastewater recycling projects. In turn, MWD dilutes the higher bromide and organic carbon levels in Delta water with Colorado River water to help reduce disinfection byproducts in treated water. In Solano County, higher quality, less variable Lake Berryessa water is blended with lower quality, highly variable North Bay Aqueduct water from the Delta. Likewise, many water suppliers have the capability to blend groundwater, local surface water, and imported supplies to achieve a desired water quality, although some utilities may choose to use water supplies based upon cost minimization or water rights considerations instead. Some water agencies even blend water and water quality from different levels of the same reservoir by using different intake levels. Many water management actions, such as conjunctive use, water banking, water use efficiency, and water transfers intentionally or unintentionally result in one type of water quality traded for, or blended with, another.

In the Upper Santa Ana River Water Basin, matching water quality to its effective use has been ongoing through a complex watershed-wide method. With the addition of the Seven Oaks Dam, water quality from the reservoir has improved, while at the same time, effluent flow downstream of the reservoir has increased. By using the increased flow of lower quality effluent for groundwater recharge, the region could increase its dry year sources while using the higher quality reservoir water for direct delivery of water for municipal uses.

Matching Water Quality to Industrial and Commercial Use

Businesses also match water quality to use. For instance, ultra pure water is needed in many manufacturing processes in the Silicon Valley and San Francisco Bay Area. In order to produce ultra pure water, manufacturers prefer higher quality (low TDS) Hetch Hetchy water over Delta or groundwater supplies that are also available in the region. The Central and West Basin Municipal Water Districts offer different qualities of recycled water at different costs that are tailored to different uses, including process water for petroleum refining. At least one concrete plant in San Francisco captures and reuses its low quality stormwater runoff for concrete production. The use of saline water and wastewater for power plant cooling has been promoted by the State Water Resources Control Board described in its Power Plant Cooling Policy adopted on June 19, 1975 (State Water Resources Control Board 1975) and implemented by the Regional Water Quality Control Boards.

Water Quality Exchange Projects

There are potential regional opportunities to exchange water to make a better match of the water quality needs of the constituent service areas. This would result in lower treatment costs and associated energy and greenhouse gas (GHG) emissions.

The CALFED Bay-Delta Program (CALFED) identified two potential water quality exchange projects, the San Joaquin Valley-Southern California Water Quality Exchange Program and the Bay Area Water Quality and Supply Reliability Program, to improve water quality and water supply reliability, as well as disaster preparedness, on a regional basis. These programs could promote matching water quality to water use with potentially no degradation to the ultimate use of the water. For instance, a local water agency in the Bay Area with access to a water supply of relatively lower water quality could fund water recycling or water conservation projects in another agency’s service area that has a higher quality water supply in exchange for the higher quality water saved by those projects. This concept is being pursued under the Bay Area Integrated Regional Water Management Plan (IRWMP) — Water Supply and Water Quality Functional Area Document (RMC 2006).

Under the San Joaquin Valley-Southern California Water Quality Exchange Program, MWD is working with both the Friant Water Users Authority and the Kings River Water Association to investigate the feasibility of exchanging water supplies. MWD is interested in these exchanges to secure higher quality Sierra water supplies that could lower their cost of treatment and increase their ability to meet more stringent drinking water quality regulations. In return for participating in the water quality exchange, Friant and Kings are interested in securing infrastructure improvements, financed by MWD, which will increase water supply reliability for their members. In this type of exchange, however, increased salinity levels are the largest water quality issue. If water is drawn from a poorer quality supply and the basin has no outlet, then the salinity level in the groundwater will increase (for further discussion, see Chapter 19, "Salt and Salinity Management," in this volume). This program is still being pursued as part of the September 2006 San Joaquin River Settlement (SJRRP 2009; *NRDC et al. v. Rogers et al*. 2006).

Statutory Language

Several sections of the California Water Code and the California Code of Regulations provide guidance for the use of water, specify legal and regulatory requirements, and therefore define the potential for utilizing this strategy including:

- The use of potable domestic water sources for nonpotable use is considered a waste and unreasonable use if recycled water of adequate quality is available (Water Code Section 13550).
- Existing water rights holders are free to use recycled water, desalinated water, or water polluted by waste to a degree which affects the water for other water quality beneficial uses over their normal higher quality water source, without fear of losing their water right due to non use (Water Code Section 1010).

Potential Benefits

Agriculture

For agricultural and instream uses, water quality matching is an integral part of water quality management because there is generally no treatment of these water supplies prior to their use.

Drinking Water

For drinking water, appropriately matching high quality source waters can reduce the levels of pollutants and pollutant precursors that cause health concerns in drinking water. In addition, less costly treatment options can be used when water utilities start with higher quality source waters. In turn, this increases water supply reliability and assures multiple barriers of protection for public health.

Municipal and Industrial

For municipal and industrial customers, using water high in salinity can damage plumbing fixtures, water-using devices, and equipment all of which increases costs. A 1999 study conducted by the U.S. Department of the Interior and MWD found that for every decrease of 100 milligrams-per-liter in salinity, there is an economic benefit of $95 million annually to MWD's customers (Bookman-Edmonston 1999).

Instream/Ecosystem Benefits

For instream uses, maintaining water temperature suitable for fish and aquatic organisms is an integral part of managing instream water quality for the benefit of the ecosystem. Temperature control devices, as used on Shasta Dam, provide reservoir operators with a mechanism to adjust the water temperature of reservoir outlet flows to meet the needs of the downstream ecosystem better.

Opportunities for Blending of Sources

Improved treated water quality and water supply reliability are also potential benefits of water quality matching for those agencies that have access to a diverse water supply portfolio. One example is the Santa Clara Valley Water District, its retail agencies, and other water suppliers along the South Bay Aqueduct which have access to Delta water, Hetch Hetchy, local surface water, and groundwater. During droughts, seawater intrusion increases the level of salinity, including bromide, in Delta water supplies. In such an event, agencies and regions with water source flexibility could use more groundwater or local surface water, if available, both of which are relatively bromide-free. When water with high levels of bromide is disinfected, there may be additional treatment costs incurred to minimize the formation of potentially carcinogenic disinfection byproducts.

Avoided Treatment Costs

Water that contains lower levels of salinity is a better match for domestic water quality uses and for irrigating salt-intolerant crops such as strawberries and avocados. As previously noted, some agencies blend water supplies to achieve a desired water quality, including salinity levels. If low salinity water supplies are unavailable, water utilities may have to treat high salinity water supplies to achieve a desired water quality. In the Chino basin, utilities already desalinate groundwater for domestic use. In the San Francisco Bay Region, the Zone 7 Water Agency and Alameda County Water District (ACWD) also desalinate groundwater for domestic use. For example, the capital costs alone of ACWD's new groundwater desalting project in Newark were $1.3 million per acre-foot per day of capacity, with operations and maintenance costs of $500 per acre-foot.

No-Cost Water Quality Exchange

In 2003 a no-cost water quality exchange was implemented between the Environmental Water Account (EWA), Kern Water Bank, and MWD. Under the exchange, EWA had purchased groundwater in Kern Water Bank, seeking to avoid a storage fee for leaving the purchased water in the bank. MWD offered to receive EWA's purchased water in exchange for providing the EWA with a surface water supply later in the year when EWA could use the water. MWD benefited from the exchange because it received groundwater supplies with low total organic carbon and bromide levels during a period when MWD was unable to blend total organic carbon levels down with Colorado River supplies.

One example of a no-cost exchange is when an urban water user provides agricultural water users with surface supplies during the peak agricultural water demand period. During these periods, agricultural users would otherwise be forced to use groundwater and might face pumping constraints. In return for access to surface supplies, the agricultural user returns a similar amount of pumped groundwater during the fall-winter period when there is excess groundwater pumping capacity and there are undesirable levels of bromide and total dissolved solids in Delta surface supplies.

In addition to water-supply benefits, the use of Delta water in groundwater recharge and banking operations may provide water quality benefits as well as substantially reducing levels of turbidity, pathogens, and organic carbon upon withdrawal. Recharge and banking will result in better quality water with respect to these pollutants if the water is percolated.

Climate Change

As precipitation patterns change, water scarcity is likely to increase. Increased conflict over how to use available water might arise. Matching water quality to use allows for multiple uses below drinking water standards (and a few above those standards) and could increase water supply reliability for urban systems, agriculture, and the environment. Climate change may have an overall negative effect on water quality; climate change impacts such as sea level rise, droughts, and floods additionally would affect water quality.

Adaptation

Generally, treating less water to higher standards may increase adaptive capacity by increasing supply reliability for drinking water. If, for example, more buildings use recycled water for toilets and irrigation, the overall demand for potable water will decrease, making urban systems more resilient when faced with diminished supplies due to climate change impacts. Taking steps such as changing plumbing codes, increasing recycled water production, and allowing for greater flexibility for agricultural irrigation system water quality can help to protect critical drinking water supplies.

Mitigation

Matching water quality to use has mitigation benefits and drawbacks. There are energy benefits from treating less water to a higher quality than is needed for the intended use. Increased energy use, however, may result from increased treatment of municipal wastewater that is sometimes necessary to make that recycled water available for safe, non-potable uses. Moreover, new distribution infrastructure will be necessary in certain instances, and the construction of that infrastructure would result in GHG emissions.

Linkages to Other Resource Management Strategies

Pollution Prevention

This strategy has a direct link to the pollution prevention strategy because maintaining water to its highest quality through pollution prevention allows greater potential uses of the water. The higher the quality of water, the greater potential there is to match quality to use.

Municipal Recycled Water

Water quality is matched to use when municipal wastewater is treated to recycled water standards for non-potable use such as irrigation. This allows greater flexibility in the use of local water supplies and reduces the amount of potable water needed for a community if recycled water replaces potable water that is used for irrigation.

Salt and Salinity Management

As water is used and reused, the potential for buildup of salts in the water makes the water less suitable for reuse. Salinity management is necessary to preserve the maximum potential uses of the water.

Groundwater/Aquifer Remediation

Matching water quality to use can be used as a management tool for aquifer protection. One example of this is in the Salinas groundwater basin where recycled water will be supplied to agriculture in lieu of groundwater. This in lieu recharge is used to combat further seawater intrusion.

Potential Costs

Water Exchange Costs

CALFED estimated that water quality exchanges could cost nearly $100 million (in 2004 dollars) during Stage 1 implementation. These costs can be broken down into costs to build the infrastructure that matches quality to use, the long-term conveyance costs, administrative costs (negotiation costs), swapping place of use, and institutional costs.

Infrastructure and Conveyance Costs

In most cases, costs for matching water quality to use will also include new conveyance systems to connect source waters different from those currently being used. Matching quality to use involves moving water from where it is available to where it is needed, incurring costs for energy, capacity, and hydraulic losses. These costs can come in the form of incentive payments for participants (e.g., the incentive for the Friant/Kings-MWD programs is MWD's willingness to invest in local infrastructure that will benefit the exchange partners).

Major Implementation Issues

Water Quality Exchanges

Water quality exchanges face similar regulatory, institutional, and third-party impact issues that water supply transfers face (for further discussion, see "Water Transfers," Chapter 8 in this volume). In particular, water supplies are generally governed by place-of-use restrictions that must be addressed when exchanging water supplies. Moreover, water quality exchanges could have adverse third-party impacts such as increasing the salinity of local groundwater, reducing the availability of higher quality instream water needed for fisheries, and limiting agriculture to salt-tolerant crops. These water quality exchanges should be evaluated for their impact on energy use and GHG emissions in addition to the increase in supply and satisfaction of increased demand.

Effluent Dominated Streams

Many streams in California have become dominated by effluent releases from wastewater and storm water releases resulting from diversions of water out of streams and lakes for beneficial human uses. In addition, many streams in the semi-arid West that were naturally and seasonally intermittent or ephemeral have become perennial due to wastewater discharges or nuisance flows from stormwater systems. The conversion from intermittent/ephemeral stream types has changed the type of ecosystem being supported. For example, the native red-legged frog thrives in ephemeral stream systems. When these systems are converted to perennial streams, bull frogs, predators of the red-legged frog, can thrive and expatriate the red-legged frog from its habitat. Water pollution reduction is typically directed at eliminating the discharge of water coming from wastewater and stormwater. This strategy could restore some native intermittent/ephemeral ecosystems, but would also remove the “created” perennial ecosystems. The opposite may occur, where effluent has replaced perennial flows, the removal of the effluent could convert historically perennial systems into ephemeral systems unless natural flows could be restored.

As water is withdrawn from streams and lakes in the rain-fed watershed, effluent discharges have been increasing. While effluent discharges might be seen as replacing the natural sources of water in some watersheds, the timing and quality of the water is much different from natural conditions. For example, the effluent is typically warmer than the natural flow from formerly snowmelt-fed or groundwater-fed streams and may contain more salts and other contaminants. This situation typically benefits nonnative fish species over native species.

Usability of Water

There is often a high cost incurred by water supplies that become either unsuitable for certain uses, or very expensive to use because of contamination. An example is the contamination of water supplies by methyl tertiary-butyl ether (MTBE, a gasoline additive that may cause cancer), which initially closed 80 percent of Santa Monica’s drinking water wells, determined in a study by the Environment California Research and Policy Center (Jahagirdar 2003). This contamination forced the city to increase its dependence on imported water sources and later to install treatment facilities to reduce MTBE levels.

Another example, a study by the University of California, Davis on nitrate contamination in the Tulare Lake basin and Salinas Valley, found that many small drinking water systems in these areas that rely on groundwater have nitrate contamination that exceeds the drinking water standard. One solution that matches water quality to use is to switch from the nitrate contaminated groundwater to surface water (Harter et al. 2012).

Salinity

Agricultural drainage, imported Colorado River water, seawater intrusion in the Delta, and coastal aquifers all contribute to increasing salinity in all types of water supplies which can adversely affect many beneficial uses including irrigation, fish and wildlife, and domestic use. The primary tool to reduce salinity impacts is matching water quality to use because many sources of salinity, such as seawater intrusion, are natural and treatment to remove salinity is relatively expensive. If the source water has less salinity, the discharge after use will also have less salinity. Further, water supplies that are high in salinity increase the cost of recycling or recharging them into aquifers for subsequent reuse. The State Water Resource Control Board adopted a Recycled Water Policy in 2009 (State Water Resources Control Board 2009-0011) that directed the Regional Water Control Boards to develop salt and nutrient management plans. In addition, the Regional Water Quality Control Boards have recognized the need to develop salt management strategies to prevent high quality waters from being degraded due to salt discharges. The Santa Ana Regional Water Quality Control Board has adopted a salt management plan and the Central Valley Regional Water Quality Control Board is working on a salt management strategy.

Operations Criteria for Storage and Conveyance

Most reservoirs and other projects, such as water transfers and the EWA described above, operate to achieve goals and objectives related to water supply, power production, flood control, fish and wildlife protection, and even recreation — but not water quality. In the Delta, there are water quality standards for project operations for salinity and temperature that protect agricultural, instream, and municipal and industrial uses. However, these ambient water quality standards do not reflect water user demand for lower salinity water supplies. Moreover, other parameters of concern for domestic uses, such as pathogens and organic carbon, do not have operating criteria and furthermore, do not have objectives in Basin Plans or discharge requirements in National Pollutant Discharge Elimination System (NPDES) permits.

Upstream and Downstream Partnerships

Few partnerships presently exist between upstream source water areas, downstream water users, and the water users in between that affect water quality, resulting in a critical disconnect in the overall system. Such partnerships could lead to pollution prevention or trading opportunities that could create more efficient water quality protection. For example, a downstream partner with an interest in protecting water quality may wish to pay for projects or initiatives in the upstream partner's area of influence. California encourages these partnerships through grants funded by various bond measures to develop and implement an IRWMP.

Ecosystem Restoration and Drinking Water Supplies

Some ecosystem restoration projects, such as wetlands restoration, may improve habitat and even some aspects of water quality, but at the same time may degrade other aspects of water quality, such as the increase of mercury or organic carbon from a drinking water perspective. The CALFED Ecosystem Restoration program has reviewed this potential conflict in matching water quality to use in the Delta. (California Department of Fish and Game 2009).

Recommendations

1. The State should facilitate and streamline water quality exchanges that are tailored to make better matches of water quality to use, while mitigating any adverse third-party impacts of such transfers, including the increase or decrease in net energy use and greenhouse gas emissions.
2. The State, local agencies, and regional planning efforts should review potential impacts on streams by projects aimed at eliminating discharge of wastewater or causing changes to the natural timing and quality of water and make recommendations on how to mitigate these impacts.
3. The State should facilitate water reuse downstream by encouraging upstream users to minimize the impacts of non-point urban and agricultural runoff and treated wastewater discharge.
4. The State should support the development of salt management plans for all watersheds where salt is a constituent of concern.
5. The State and local agencies should better incorporate water quality into reservoir, Delta, and local water supply operations, as well as facility reoperation and construction. For example, the timing of diversions from the Delta, and thereby the concentrations of salinity and organic car-

bon in those waters, could be better matched to domestic, agricultural, and environmental uses. Alternatively, the timing and location of urban and agricultural discharges to water sources, including the Delta, could also be coordinated with the eventual use of water conveyed by potentially impacted diversions. Facilities conveying municipal and industrial water could also be separated from those conveying water for irrigation.

6. The State, local water agencies, and regional planning efforts should manage water supplies to optimize and match water quality to the highest possible use (e.g., drinking water) and to the appropriate treatment technology.
7. Consistent with the watershed-based source-to-tap strategy recommended in “Pollution Prevention,” Chapter 18 in this volume, the State should facilitate systemwide partnerships between upstream watershed communities and downstream users along the flow path in order to find ways to make better matches of water quality to use. Ongoing integrated regional water management planning efforts are facilitating systemwide partnerships to make better matches of water quality to use.
8. The State should support research for solutions to the potential conflicts between ecosystem restoration projects and water quality for drinking water.

Matching Water Quality to Use in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions are not consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy is not discussed in the rest of Update 2013), there is no need for this section to appear.]

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Chapter 18. Pollution Prevention — Table of Contents

Boxes

Chapter 18. Pollution Prevention

Pollution prevention can be defined as the reducing or eliminating of waste at the source by modifying production processes, promoting the use of non-toxic or less toxic substances, the implementation of practices or conservation techniques including activities that reduce the generation and/or discharge of the pollutants, and the application of innovative and alternative technologies which prevent pollutants from entering the environment prior to treatment. These preventive activities can also include new equipment designs or technology, reformulation or redesign of products, substitution of raw materials, updating or improvements of existing management practices, continued maintenance of previously implemented management practices, training and education/outreach, and improved collaboration.

Pollution prevention begins at the source. Sources of water quality pollution can be categorized into two types: point-source and non-point-source. In California, point-source pollution prevention is addressed through the Clean Water Enforcement and Pollution Prevention Act of 1999, Water Code Section 13263.3(d)(1), which authorizes the State Water Resources Control Board (SWRCB), a Regional Water Quality Control Board (RWQCB), or a publicly owned treatment works (POTW) to require a discharger to prepare and implement a pollution prevention plan. A point-source discharger is defined per Water Code Section 13263.3(c) as any entity required to obtain National Pollutant Discharge Elimination System (NPDES) permit or any entity subject to the federal pretreatment program. A non-point discharger is any discharger not covered by a NPDES permit.

Pollution prevention can improve water quality for all beneficial uses by protecting water at its source and therefore reducing the need and cost for other water management and treatment options. By preventing pollution, restoring, and then protecting improved water quality throughout a watershed, water supplies can be used and reused by a greater number and types of downstream water uses. Improving water quality by protecting source water is consistent with a watershed management approach to water resources problems.

Under the public trust doctrine, certain resources are held to be the property of all citizens and are subject to continuing supervision by the State. Originally, the public trust was limited to commerce, navigation, and fisheries, but over the years, the courts have broadened the definition to include recreational and other ecological values.

As increasing emphasis is placed on protecting instream uses for fish, wildlife, recreation, and scenic enjoyment, surface water allocations administered under ever-tightening restrictions are posing new challenges and giving new direction to the SWRCB’s water rights activities. In a landmark case, National Audubon Society v. Superior Court, the California Supreme Court held that California water law is an integration of both public trust and appropriative right systems, and that all appropriations may be subject to review if “changing circumstances” warrant their reconsideration and reallocation. At the same time, it held that like other uses, public trust values are subject to the reasonable and beneficial use provisions of the California Constitution. Together with the SWRCB, the courts have concurrent jurisdiction in this area.

The difficulty comes in balancing the potential value of a proposed or existing water diversion with the impact it may have on the public trust. After carefully weighing the issues and arriving at a determination, the SWRCB is charged with implementing the action, which would protect the latter. The courts also have concurrent jurisdiction in this area.

As with all of the other pieces of the California water puzzle, protecting through pollution prevention, restoring/improving impaired water quality, and allocating the limited resource fairly and impartially among many competing users (while not creating or increasing water quality pollution issues with these allocations), are among some of the SWRCB's greatest challenges.

Pollution Prevention in California

In the past, the main water pollution prevention focus was primarily on those from point-source discharges. Pollution can enter a water body from point-sources like municipal wastewater treatment facilities, industrial wastewater treatment facilities, or municipal discharges from stormwater runoff. In recent years, however, as point-sources have been more effectively regulated and controlled, the remaining so-called "non-point-sources" (NPS) of pollution have become one of the main concerns of the SWQCB and RWQCBs. These NPS pollutants are generated from a variety of sources, including land use activities associated with agricultural operations and livestock grazing, forestry (silviculture) practices, uncontrolled urban runoff not covered by permits, deposition of airborne pollutants, hydromodification, and discharges from marinas and recreational boating activities. There are many approaches such as regulations (e.g., dischargers under the Water Code), voluntary/self-determined (e.g., locally led entities that desire a cleaner environment and that conduct riparian and ecosystem restoration activities), or incentive-based (e.g., U.S. Department of Agriculture Natural Resource Conservation Service Environmental Quality Incentives Program (EQIP) -National Water Quality Initiatives funding for implementing Agriculturally-based Management Practices) that are available for preventing NPS water pollution. Understanding, planning for, assessing, documenting, managing, tracking, and controlling NPS pollution through better land use management has been and will continue to be developed. Additional information on land use is available in the Land Use Categories and Pollution Prevention section in this chapter or in the Land Use Planning and Management, Chapter 24 in this volume.

Coordinating the prevention of both point- and non-point sources of pollution in concert with one another has been shown to help identify priority areas of focus. As resources continue to become increasingly limited, the ability to identify and focus funding resources through coordinated efforts will be of great importance.

The U.S. Environmental Protection Agency (USEPA), SWRCB, California Coastal Commission (CCC), and RWQCBs coordinate closely on NPS pollution issues. These agencies implement permitting, enforcement, remediation, monitoring, and watershed-based programs to prevent pollution. In addition, as part of California's NPS Program Fifteen-Year Strategy (NPS Program Strategy) that started in 1998, the SWRCB established an Interagency Coordinating Committee (IACC) to assist other state agencies with NPS regulatory authorities and/or land use responsibilities to familiarize themselves with each others' NPS activities, and to better leverage their resources. The Irrigated Lands Regulatory Program Roundtables and the Marina's IACC meetings continue to be two of the most effective of these originally formed groups.

NPS dischargers are responsible for ensuring that their discharges do not adversely impact water quality in the state. In an effort to prevent pollution, restore impaired water quality, and protect improved water quality, a number of government agencies provide funding for water quality projects using state bond funded grants and loans, and federal Clean Water Act section 319 (CWA 319) implementation grants. Some of the government agencies that administer and provide this funding include the SWRCB, Department of Water Resources, Department of Pesticide Regulations, Department of Conservation, and U.S. EPA. Unless new state water bond funding is approved by voters in the coming years, these bond funds will eventually be depleted with only the CWA 319 implementation grants continuing through the SWRCB. The amount of federal funding made available to the SWRCB for CWA 319 implementation grants has declined by 13% in 2010 and 10% in 2011. This funding is expected to continue to decline in the future. The need for increased CWA 319 federal funding and improved collaboration, cooperation, and leveraging of all funding sources will be extremely important in order to sustain a high level of water quality improvements, pollution prevention, and restoration efforts. The SWRCB NPS Program has identified watershed-based plan development and funding coordination for implementation as a high priority.

Pollution prevention can require a cultural change, one that encourages more anticipation and internalizing of real environmental costs by those who may generate pollution, and which also requires building a new relationship with all stakeholders to find the most cost-effective means to achieve those goals.

Antidegradation Policies

Pollution prevention can be provided through the adoption and implementation of policies to protect and/or maintain high water quality. The federal Clean Water Act requires each state to adopt a statewide antidegradation policy and establish procedures for its implementation. The California and federal antidegradation policies require, in part, that where surface waters have a higher quality than necessary to protect beneficial uses (e.g., designated uses of the water which can include, but are not limited to, domestic, municipal, agricultural and industrial supply, power generation, recreation, aesthetic enjoyment, navigation, and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves), the high quality of those waters must be maintained unless otherwise provided for by the policies. The federal antidegradation policy prohibits any activity or discharge that would lower the quality of surface water that does not have assimilative capacity with limited exceptions. The California Antidegradation Policy, which pre-dates the federal Clean Water Act, was adopted by the SWRCB in 1968 as SWRCB Resolution No. 68-16. SWRCB Resolution 68-16 establishes the requirement that state water discharges be regulated to achieve the “highest water quality consistent with maximum benefit to the people of the state.” The state’s Antidegradation Policy applies more comprehensively to water quality changes than the federal policy because it also applies to groundwater and not just surface water.

The Antidegradation Policy has been incorporated into all RWQCBs’ water quality control plans (basin plans). A basin plan establishes a comprehensive program of actions designed to preserve, enhance, and restore water quality in all water bodies within the state. The basin plan is each RWQCB’s master water quality control planning document and includes the beneficial uses of water within the RWQCB’s jurisdiction, water quality objectives to protect the beneficial uses, and a program of implementation to achieve the water quality objectives. Federal laws require states to adopt water quality standards. In California, the beneficial uses and water quality objectives are the state’s water quality standards.

Water Quality Monitoring

California Water Quality Monitoring Council

Senate Bill 1070 was enacted to orchestrate more effectively the many water quality monitoring efforts already in progress within the state, and to make that process more visible to users and to entities committed to the protection, monitoring, and supply of water to all its users. It provides for the creation of a structure to allow the public to access any available water quality data, current methods and research, as well as current regulations and enforcement actions. The bill also created the California Water Quality Monitoring Council to connect the myriad activities throughout the state in a more cohesive and sensible manner with the ability to provide direction to reduce redundancies, prioritize actions, and recommend funding necessary to provide the critical information necessary to protect California's water.

The California Water Quality Monitoring Council provides multiple perspectives on water quality information and highlights existing data gaps and inconsistencies in data collection and interpretation, thereby identifying areas for needed improvement in order to address the public's questions. The Monitoring Council has developed a set of "My Water Quality" Internet portals supported by expert stakeholder work groups, which include members from local, state, federal, and non-governmental organizations. The initial Internet portals were developed around water quality themes in an easy to understand manner and to answer the following water quality questions:

- Is It Safe To Swim In Our Waters?
- Is It Safe To Eat Fish and Shellfish From Our Waters?
- Are Our Ecosystems Healthy?

Additional "My Water Quality" Internet portals are planned and will address the following water quality questions:

- Is Our Water Safe to Drink?
- Are Our Stream and River Ecosystems Healthy?
- Are Our Tidepool Ecosystems Healthy?
- Are Our Estuary Ecosystems Healthy?
- Are Our Ocean Ecosystems Healthy?

Surface Water Ambient Monitoring Program

The Surface Water Ambient Monitoring Program (SWAMP) is a statewide monitoring effort that provides the scientifically sound data necessary to manage California's water resources effectively. Ambient monitoring refers to the collection of information about the status of the physical, chemical, and biological characteristics of the environment. The SWRCB and the RWQCBs introduced SWAMP in 2001. The program's purpose is to monitor and assess water quality to determine whether California is meeting its water quality standards and protecting its beneficial uses. Data from SWAMP are used to improve the state's water quality assessment and impaired water bodies list, required under CWA Sections 305(b) and 303(d), respectively. In addition, regional efforts underway by the Central Coast Ambient Monitoring Program are briefly described in Box 18-1.

PLACEHOLDER Box 18-1 Central Coast Ambient Monitoring Program

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Groundwater Ambient Monitoring and Assessment Program

The Groundwater Ambient Monitoring and Assessment (GAMA) Program was created in 2000 by the SWRCB and it is California's comprehensive groundwater quality monitoring program. GAMA collects data by testing the untreated, raw water in different types of wells for naturally-occurring and human-made chemicals. GAMA compiles these test results with existing groundwater quality data from several agencies into a publicly-accessible Internet database called Geo-Tracker GAMA and is available at http://geotracker.waterboards.ca.gov/gama/. The main goals of GAMA are to improve statewide groundwater monitoring and increase the availability of groundwater quality information to the public.

California Monitoring and Assessment Program

In 2004, California Monitoring and Assessment Program for Wadeable Perennial Streams was initiated. This program builds on U.S. EPA's Environmental Monitoring and Assessment Program using a probabilistic monitoring design incorporating land use classes to allow for assessments of status and trends in aquatic life beneficial use protection in streams. Historic Environmental Monitoring and Assessment Program data were analyzed to produce assessments of the condition of streams statewide and in special study areas in Northern and Southern coastal California. Several assessments will also be completed focusing on providing water quality information statewide, and for the broad land use categories such as urban, agriculture, and forested areas. Based upon the highly extrapolative nature of this program, practitioners with intimate familiarity with specific water body conditions have questioned the sensitivity of this approach to identifying barriers to migration, which cause impairment to anadromous fish populations in water bodies displaying generally good water quality. These efforts directly relate to Recommendation 3 of this strategy in the 2005 California Water Plan and can be seen as some success in responding to this recommendation.

Since 2000, California has conducted three successive probability surveys of its perennial streams and rivers, each with a focus on biological endpoints. These surveys are now combined and are managed collectively by the SWAMP under its Perennial Streams Assessment Program. In 2010, SWAMP's Perennial Streams Assessment conducted the SWRCB's eleventh continuous year of probability monitoring of perennial, wadeable streams. To date, the program has collected biological data (invertebrates, algae) and associated chemical and habitat data from approximately 850 probabilistic sites statewide. These surveys have produced a wealth of data that can and should be used to inform many decisions made by California's water resource agencies. For example, the assessments in the 2006 *California Water Quality Assessment Report* (Clean Water Act Section 305(b) Report) were based in large part on data from these surveys. Data from these surveys were also used in the development of the *2010 Integrated Report* (Ode, Kincaid, Fleming, Rehn 2011).

Surface Water Quality Assessment and Total Maximum Daily Loads (TMDLs)

The CWA Section 305(b) requires each state to report biennially on the quality and condition of its waters. CWA Section 303(d)(1)(A) requires each state to identify waters within its boundaries which are not meeting water quality standards. The reports submitted by states serve as the basis for U.S. EPA's *National Water Quality Inventory Report to Congress*. The SWRCB and RWQCBs conduct physical, chemical, and biological monitoring of the waters of the state and prepare a biennial assessment report for U.S. EPA (SWRCB 2012a).

California's CWA Section 303(d) (CWA 303d) Listing Policy sets the rules to identify which waters do not meet water quality standards, even after point-source dischargers have installed the required levels of pollution control technology (SWRCB 2009a). The federal law requires that states establish priority rankings for water on the CWA Section 303(d) list and develop action plans, called Total Maximum Daily Loads (TMDLs) for specific pollutants to improve water quality and protect designated beneficial uses. TMDLs can take various forms, but most commonly are adopted through the basin plans for the region.

Water bodies are most often listed as impaired for sediment, pathogens, nutrients, increased temperature, pesticides, metals, and organic chemicals. The resulting TMDLs are then implemented through the point-source and NPS regulatory programs such as:

- National Pollutant Discharge Elimination System (NPDES) permits for point-sources (e.g., wastewater treatment facilities, stormwater runoff).
- State waste discharge requirements (WDRs) for point-sources not subject to the NPDES permit program and non-point-source (NPS) discharges.
- Prohibitions for discharges other than agriculture.
- Conditional waivers of WDRs.

Multiple pollutants can be addressed in a single TMDL or multiple water bodies in a watershed may be addressed in a single TMDL. The RWQCBs are currently developing more than 181 TMDLs, addressing approximately 255 listings in 2011-12. Schedules have been developed for establishing all required TMDLs during a 13-year period. More detailed schedules of work to be undertaken in the short-term have also been developed. The SWRCB *Annual Performance Report* currently provides the number of TMDLs adopted, number of listings addressed by TMDLs, and total number of listings remaining. These performance reports are updated annually and are available at http://www.waterboards.ca.gov/about_us/performance_report_1112/plan_assess/#more.

Many significant pollution problems today are the result of persistent legacy pollutants, such as mercury, that were extracted from the Coastal Range and were used to process gold in the Sierra Nevada mines in the 19th century, industrial chemicals, such as polychlorinated biphenyls (PCBs) used in electrical transformers, and pesticides such as dichlorodiphenyltrichloroethane (DDT). These pollutants also contaminate sediments, making ecosystem restoration efforts more difficult. Hydraulic mining during the 1900s still has an adverse impact on numerous Central Valley rivers and the San Francisco Bay, as well as major parts of the Klamath River watershed. Some environmental contaminants of concern, such as mercury, selenium, PCBs, and DDT are persistent and/or are bioaccumulative. Their concentration and toxicity magnify in the food chain and could be toxic to key food chain links such as aquatic invertebrates. These contaminants also negatively impact communities and Native American tribes dependent upon subsistence fisheries.

In 2011, the U.S. EPA issued its final decision regarding the water bodies and pollutants added to California's 303(d) Lists and 305(b) Reports, referred to as the *2010 Integrated Report*. This supersedes the 2006 California Clean Water Act 303(d) List as California's current 303(d) List. The 2010 California CWA 303(d) List now includes 87,399 impaired river miles and 7,582,984 acres of impaired lakes and bays. In some cases, a water body is listed for more than one pollutant. There are a total of 3,489 pollutant-water body listings. There have been a total of 1,473 listings addressed, 957 of which were addressed by a TMDL and during the 2010 303(d) listing cycle, and 122 de-listings to date. The *2010*

Integrated Report includes a web-based interactive map and is available at http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml.

Groundwater Quality

Human activities increase the discharge of salt, nitrates/nutrients, and other pollutants to land. Such activities include the application of fertilizers (even at accepted optimal agronomic rates), application of imported water for irrigation containing dissolved salts, and industrial, municipal, and domestic wastewater discharges. Salts are leached to groundwater by rainfall or irrigation practices. Additionally, salts in native soils can be dissolved by irrigation water and leached to groundwater. For additional discussion, see Chapter 19, Salt and Salinity Management in this volume.

Nitrate pollution of groundwater results from various sources including the use of nitrogen fertilizers, percolation of wastewater treatment plant and food processing wastes, leachate from septic system drainfields, animal corals, manure storage lagoons, urban parks, lawns, golf courses, and leaky sewer systems. A recent study of the Tulare Lake basin and Salinas Valley growing areas found that nitrate from agricultural fertilizer is the largest threat to groundwater quality in these areas (Harter et al. 2012). Nitrate contamination of community water system wells is also the most frequently detected anthropogenic (human-caused) contaminant, affecting more than 450 wells that are used by more than 200 community water systems statewide (SWRCB 2013). Wellhead treatment programs and blending with higher quality water are both effective at reducing the nitrate level in drinking water supplies. However, the extra cost to remove or reduce nitrate to below safe levels is often expensive and unaffordable for disadvantaged communities. Individual residences served by domestic wells are also at risk if these are located in or near known areas of nitrate contamination. Domestic wells generally tap shallow groundwater making them more susceptible to contamination. Many of these well owners are unaware of the quality of the well water, because the State does not require them to test their water quality. For additional discussion on groundwater contamination, see Chapter 16, Groundwater/Aquifer Remediation in this volume.

Groundwater Recharge Area Protection

Protecting recharge areas is important since they provide a primary means to replenishing groundwater supplies. Good natural recharge areas are those where good quality surface water is able to percolate unimpeded to groundwater. If recharge areas cease functioning properly, there may be insufficient groundwater storage for later use. Protection of recharge areas requires a number of actions based on two primary goals: (1) ensuring that areas suitable for recharge continue to be capable of adequate recharge rather than become covered by urban infrastructure such as buildings and roads, and (2) preventing pollutants from entering the groundwater in order to avoid expensive treatment that would be needed prior to potable, agricultural, or industrial uses.

Protection of recharge areas is necessary to maintain the quantity and quality of groundwater in the aquifer. However, protecting recharge areas by itself does not provide a supply of water. Recharge areas only function when aquifer storage capacity is available, and when regional and local governments and agencies work together to protect or secure an adequate supply of good quality water to recharge the aquifer. Climate change may alter precipitation and runoff patterns, which will impact groundwater recharge (see the Climate Change section in this chapter). Protecting existing and potential recharge areas allows them to serve as valuable components of a conjunctive management and a groundwater storage strategy.

Zoning can play a major role in protecting a recharge area by amending land use practices so that existing recharge sites are retained as recharge areas. In the past, some areas that provided good rates of recharge were paved over or built upon and are no longer available to recharge the aquifer. Local governments often lack a clear understanding of recharge areas and the need to protect those areas from development or contamination. Land use zoning staff does not always recognize the need for recharge area protection for water quantity and water quality. For further discussion, see Chapter 25, Recharge Area Protection in this volume.

Drinking Water Source Assessment and Protection

Drinking water originates from streams, rivers, lakes, and underground aquifers. These sources usually require water treatment to remove contaminants before it is delivered to customers as drinking water. However, the cost and level of water treatment, as well as the risks to public health, can all be reduced by protecting source water from contamination. Establishing drinking water source assessment and protection programs are necessary to identify contaminating activities and implement practices to protect source water. Ultimately, everyone from government agencies to local communities, including business and citizens, plays a role to ensure that drinking water sources are protected.

Assessment of Drinking Water Sources

The assessment of drinking water sources is the first step to develop a complete drinking water source protection program. A source water assessment is a study that defines the land area contributing water to a public water system source, identifies the major potential contamination activities that could affect the drinking water supply, and determines how susceptible the public water supply is to this potential contamination. The Safe Drinking Water Act requires states to develop U.S. EPA-approved programs to carry out assessments of all source waters in their state. Local communities, water systems, and citizens can then use the publicly available study results to the take actions to reduce potential sources of contamination and protect drinking water (U.S. EPA 2012). In California, most source water assessments for public drinking water sources have been completed and are available at http://swap.ice.ucdavis.edu/TSinfo/TSintro.asp.

In addition to source water assessments, public water systems that treat surface water are required to conduct a watershed sanitary survey every five years. At a minimum, this survey includes:

- Physical and hydrogeological description of the watershed.
- Summary of source water quality monitoring data.
- Description of watershed activities and sources of contamination that affect source water quality.
- Description of any significant changes that have occurred since the last survey, which could affect the source water quality.
- Description of watershed control and management practices.
- Evaluation of the system's ability to meet water treatment requirements.
- Recommendations for corrective actions to improve source water quality.

These watershed sanitary surveys provide an assessment of the watershed, identify possible contamination sources, and recommends actions needed to protect and improve source water quality.

Protection of Drinking Water Sources

In California, drinking water systems are encouraged to establish a source water protection program to protect their supply sources from contamination. Source water protection measures are practices to prevent contamination of groundwater and surface water that are used or are potentially used as sources of drinking water. These include non-regulatory measures, such as Best Management Practices (BMPs), and regulatory methods such as issuing permits. A source water protection program is a valuable tool for the following reasons:

- It is the most cost-effective method to ensure the safety of a drinking water supply.
- It is part of a multi-barrier approach to provide safe drinking water; treatment alone cannot always be successful in removing contaminants.
- It improves public perception of the safety of drinking water.
- It helps to ensure safe drinking water that is essential for public health and economic well-being of communities.

A drinking water source protection program envisions a partnership between local, state, and federal agencies to ensure that the quality of drinking water sources is maintained and protected. Recently, the Central Valley RWQCB launched a multi-year effort to develop a drinking water policy for surface waters in the Central Valley, see Box 18-2.

PLACEHOLDER Box 18-2 Central Valley Drinking Water Source Policy

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Land Use Categories and Pollution Prevention

The state NPS Program addresses NPS pollution by promoting management measures (MMs) and management practices (MPs) for each of the six separate land use categories: agriculture, urban, forestry (silviculture), marinas and recreational boating, hydromodification, and wetlands. Management measures serve as general goals for the control and prevention of polluted runoff. Site-specific MPs are then used to achieve the goals of each management measure. Management practices refer to specific technologies, processes, siting criteria, operating methods, or other alternatives to control NPS pollution.

The SWRCB, the RWQCBs, and the California Coastal Commission have developed and adopted successive, five-year plans (NPS Implementation Plans) to implement the NPS Program Strategy. The NPS 15-Year Strategy (1998-2013) focuses on the progress made in the NPS Program thus far, describes the additional regulatory, educational, and financial tools made available to the RWQCBs, and identifies the need for prioritizing resources and efforts. The goals of the current NPS Implementation Plan are similar to those of the past five-year plans (2008-2013) with a closer focus on the following activities:

- Implementing the Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program (NPS Implementation and Enforcement Policy) by the RWQCBs, particularly through the RWQCB's use of regulatory tools.
- Concentrating NPS resources on TMDL planning, assessment and implementation priorities, and shifting these funds away from pollution prevention outreach.

- Improve coordination and leveraging of resources with other funding organizations such as USDA (EQIP), SWRCB's Clean Water State Revolving Fund (CWSRF), Department of Conservation Watershed Program Grants, Department of Water Resources Integrated Regional Water Management, and others.
- Focusing overall efforts and resources on high priority watersheds and problems, as defined by priority TMDLs and other region-specific problems.
- Acknowledging the balancing act required by SWRCB programs to clean up waters polluted by non-point-sources and to preserve clean waters.

In the next five years, the SWRCB expects to have a fully integrated database of existing and tested management measures and management practices, many success stories based on proper implementation and maintenance of these measures and practices, well-established cleanup programs based on actions taken pursuant to the NPS Implementation and Enforcement Policy, and an accurate assessment of the remaining NPS pollution problems in the state. The NPS Program Strategy will be updated by the SWRCB NPS Program after receiving new U.S. EPA NPS Program Plan guidance. The goal of this new guidance is to ensure a more cohesive and consistent set of NPS Strategies and reporting requirements for all states. At this time, the SWRCB will be well-positioned to take another long-term look at the future of NPS pollution cleanup priorities.

The SWRCB has developed the NPS Encyclopedia (http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia.shtm) to help practitioners choose management practices for implementation. It is a free, online reference guide designed to facilitate a basic understanding of NPS pollution control and to provide quick access to essential information from a variety of sources. This is done through hyperlinks to other resources available on the Internet. The purpose of the NPS Encyclopedia is to support the implementation and development of the NPS aspects of TMDLs and watershed action plans with a goal of protecting high quality waters and restoring impaired waters. The companion tool, the Management Practices MP Miner (http://mpminer.waterboards.ca.gov/mpminer/), allows users to cull data from studies of management practices, peer reviewed and otherwise, by filtering studies using relevant site-specific variables, such as land use category, pollutant of concern, and removal efficiency required. Both tools are available at the SWRCB Web site as indicated above.

Agriculture

Agricultural activities that cause NPS pollution can include poorly located or managed animal feeding operations, overgrazing, plowing too often or at the wrong time, and improper, excessive, or poorly timed application of pesticides, irrigation water, and fertilizer. Farm and ranching pollutants include sediment, nutrients, pathogens, pesticides, metals, and salts. To control NPS pollutants generated from this land use category, agricultural management measures should address:

- Erosion and sediment control.
- Facility wastewater and runoff from confined animal facilities.
- Nutrient management.
- Pesticide application.
- Grazing management.
- Irrigation water management.
- Education and outreach.

Urban

Controlling polluted runoff in urban areas is a challenge. Negative impacts of urbanization on coastal and estuarine waters are well documented in a number of publications including California's CWA Section 305(b) and Section 303(d) reports and the Nationwide Urban Runoff Program. Major pollutants found in runoff from urban areas include sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, plastics, pesticides, pathogenic bacteria, and viruses. In addition to organic carbon and pathogens, suspended sediments constitute the largest mass of pollutant loadings from urban areas into receiving waters. Construction is a major source of sediment erosion. Petroleum hydrocarbons result mostly from automobile sources. Plastics, including plastic bags and bottles, are mainly the result of urban runoff. Nutrient and bacterial sources include garden fertilizers, leaves, grass clippings, pet wastes, homeless encampments, and faulty septic tanks. As population densities increase, there is a corresponding increase in trash and pollutant loadings that is generated from human activities. Many of these pollutants enter surface waters via runoff without undergoing treatment. To control NPS pollutants generated from this land use category, urban management measures should address:

- Runoff from developing areas, construction sites, and existing development.
- Septic tank systems.
- Transportation development (roads, highways, and bridges).
- Education and outreach.

Forestry (Silviculture)

Silviculture can contribute pollution to rivers and lakes. Without adequate controls, forestry operations may degrade the characteristics of waters that receive drainage from forest lands. Sediment concentrations can increase due to accelerated erosion, water temperatures can increase due to removal of over-story riparian shade, dissolved oxygen can be depleted due to the accumulation of slash and other organic debris, and concentrations of organic and inorganic chemicals can increase due to harvesting, fertilizers, and pesticides. To control NPS pollutants generated from this land use category, forestry management measures should address:

- Preharvest planning.
- Streamside management areas.
- Road construction/reconstruction.
- Road management.
- Timber harvesting.
- Site preparation/forest regeneration.
- Fire management.
- Revegetation of disturbed areas.
- Forest chemical applications.
- Wetland forest management.
- Postharvest evaluation.
- Education and outreach.

Marinas and Recreational Boating

Recreational boating and marinas are increasingly popular uses of coastal areas and inland surface water bodies (e.g., lakes, the Sacramento-San Joaquin Delta, and San Francisco Bay), and they are an important means of public access to navigable waterways. Therefore, California must balance the need for protecting the environment and the need to provide adequate public access. Because marinas and boats are located at the water's edge, pollutants generated from these sources are less likely to be buffered or filtered by natural processes. When boating and adjunct activities (e.g., those that take place at marinas and boat maintenance areas) are poorly planned or managed, they may pose a threat to water quality and the health of aquatic systems.

Water quality issues associated with marinas and recreational boating include:

- Poorly flushed waterways.
- Pollutants discharged from the normal operation of boats (recreational boats, commercial boats, and live-aboards).
- Pollutants carried in stormwater runoff from marinas, ramps, and related facilities.
- Physical alteration of wetlands and of shellfish/other benthic communities during construction of marinas, ramps, and related facilities.
- Pollutants generated from boat maintenance activities on land and in the water.
- Dredging in marinas and boat maintenance areas.
- Introductions of aquatic invasive species, both plant and animal, that degrade water quality, ecosystem processes, and water infrastructure.

Common pollutants generated from marinas and recreational boating activities include copper, bacteria and pathogens, oil and grease, nutrients, and aquatic and invasive species such as quagga mussels and *Caulerpa taxifolia*. To control NPS pollutants generated from this land use category, marina and recreational boating management measures should include:

- Marina facility assessment, siting, and design – water quality assessment, marina flushing, habitat assessment, shoreline stabilization, stormwater runoff, fueling station design, sewage facilities, and waste management facilities.
- Operation and maintenance – solid waste control, fish waste control, liquid material control, petroleum control, boat cleaning and maintenance, sewage facility maintenance, and boat operations.
- Education and outreach.

Hydromodification

Hydromodifications that can impair water quality include channel modification (channelization), flow alterations, levees, and dams. Channel modification activities are undertaken in rivers or streams to straighten, enlarge, deepen, or relocate the channel. These activities can affect water temperature, change the natural supply of fresh water to a water body, and alter rates and paths of sediment erosion, transport, and deposition. Hardening the banks of waterways with shoreline protection or armor also accelerates the movement of surface water and pollutants from the upper reaches of watersheds into coastal waters.

Channelization can also reduce the suitability of instream and streamside habitat for fish and wildlife by depriving wetlands and estuarine shorelines of beneficially-enriching sediments, affecting the ability of natural systems to filter pollutants, and interrupting the life stages of aquatic organisms. Dams can adversely impact hydrology, the quality of surface waters, and riparian habitat in the waterways where the dams are located. A variety of impacts can result from the siting, construction, and operation of these facilities. For example, improper siting of dams can inundate both upstream and downstream areas of a waterway. Dams reduce downstream flows, thus depriving wetlands and riparian areas of water. During dam construction or dredging, removal of vegetation and disturbance of underlying sediments can increase turbidity and cause excessive sedimentation in the waterway. Further, metered flows from dams fail to exert the forces that build and maintain channel structure and beneficial floodplain functions.

The erosion of shorelines and streambanks is a natural process that can have either beneficial or adverse impacts on riparian habitat. Excessively high sediment loads resulting from erosion can smother submerged aquatic vegetation, cover shellfish beds and tidal flats, fill in riffle pools, and contribute to increased levels of turbidity and nutrients (U.S. EPA 2009a). To control NPS pollutants generated from this land use category, hydromodification management measures should address:

- Channelization-channel modification.
- Dam construction and operation – erosion and sediment control and chemical pollutant control issues, and the downstream impact of reservoir releases on riparian habitat.
- Streambank and shoreline erosion control.
- Education and outreach.

Wetlands

Wetlands and riparian areas reduce polluted runoff and enhance water quality by filtering out runoff-related contaminants, such as fine-grained sediment, nutrients (nitrogen and phosphorus), and some metals. Functional wetlands and riparian systems provide other services such as surface and groundwater storage, flood control (with adequate set-backs), and storm surge attenuation. They also support valuable wildlife and aquatic habitats. Highly modified wetlands and riparian systems are typically managed for a few beneficial uses or services, are costly to maintain, and have questionable long-term sustainability. Natural wetlands are self-sustaining when not adversely impacted by pollution.

Changes in hydrology, soil texture, water quantity, and/or species composition can impair the ability of wetland or riparian areas to filter out excess sediment and nutrients and therefore can result in deteriorated water quality. Wetlands and riparian areas may be impacted or destroyed by construction, filling, or other alterations. Historically, significant losses of wetlands have been caused by draining wetland soils for conversion to croplands, or dredging wetland soils for waterway navigation. Spongy wetland soils are compacted by over-grazing and grading. Loss of wetland acreage increases polluted runoff, leading to degradation of surface water quality.

To control NPS pollutants generated from this land use category, wetlands management measures should address:

- Protection of wetlands and riparian areas.
- Restoration of wetlands and riparian areas.
- Vegetated treatment systems.
- Education and outreach.

Potential Benefits

For the vast majority of contaminants, it is generally accepted that a pollution prevention approach to water quality is more cost-effective than end-of-the-pipe treatment of wastes or advanced domestic water treatment for drinking water. Pollution prevention measures that treat or manage concentrated pollutants at the source are usually more cost-effective and practical than attempting to treat larger downstream flows that have diluted the pollutant. By preventing further degradation of water through pollution prevention, there is an overall improvement of water quality over time in both surface and groundwater.

Pollution prevention can be considered in the context of adaptation, while pollution treatment is generally associated with mitigation.

Pollution prevention activities, such as stormwater runoff management and low-impact development, can reduce or maintain the peak runoff from urbanized areas such that they can meet the channel capacity of the natural system without the need to construct new protection structures. Additional information is available in Chapter 20, Urban Stormwater Runoff Management in this volume.

Small rural water systems, which generally lack technical and financial capacities, may be more reliant upon pollution prevention measures than other options available to larger systems, such as advanced treatment. When surface water is polluted, the only other available source is groundwater. Therefore, preventing pollution of surface water keeps options for water supply open, which is especially important in areas where the groundwater resources may already be in overdraft.

By protecting the quality of surface water and near-shore coastal waters, this management strategy provides multiple benefits or uses by providing opportunities for water recreation activities, as well as serving as a water source for desalination plants, and maintaining suitable habitat for wildlife. A number of NPS success stories have been highlighted by U.S. EPA, see Box 18-3 for additional information.

PLACEHOLDER Box 18-3 U.S. EPA Non-point-Source Success Stories

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Potential Costs

According to the 2008 U.S. EPA Clean Watersheds Needs Survey, California needs more than $30 billion to meet water quality and water-related public health goals of the Clean Water Act (U.S. EPA 2009b). This survey emphasized point-source discharges from wastewater treatment systems, which estimated more than $20 billion is needed to prevent point-source discharges. Measures to address and prevent NPS pollution were likely underestimated. Currently, U.S. EPA is conducting the 2012 Clean Watersheds Needs Survey and the timeline to release the final report in late 2013. There have been a number of requests and recommendations to represent the funding need for NPS pollution more accurately in the 2012 survey.

An assessment of water quality conditions in California shows that NPS pollution has the greatest effect on water quality. It affects some of the largest economic segments of the state's economy, ranging from agriculture to the tourist industry. As previously discussed, non-point-sources are not readily controlled by conventional means. Instead, they are controlled with preventive plans and practices used by those directly involved in those activities and by those overseeing such activities. The following examples provide some insight into the complexity and costs associated with NPS pollution prevention in California.

Clean Beaches

Runoff from urban areas can contain heavy metals, pesticides, petroleum hydrocarbons, trash, plastics, and animal and human waste (Heal the Bay 2009). This urban runoff can have a detrimental impact on one of California's greatest natural and economic resources, its world-renowned beaches. This natural resource attracts millions of tourists and locals each year. The direct revenues generated by the California beach economy are substantial. Unfortunately, runoff from creeks, rivers, and storm drains creates the largest source of water pollution for the beaches. Often the currents in the bays, around offshore islands, and along sections of the coast can exacerbate pollution by trapping or directing pollutant to a particular area along the coast. Some stretches of beaches in Southern California are permanently posted by local health departments as being unsafe for swimming and surfing, or they periodically post such warnings after storm events. It is recommended that no one swim in the ocean during a significant rain event and for at least three days following a significant rain event due to contaminated urban stormwater runoff draining directly into the ocean. During dry weather, California beaches experience much better water quality, although sewer spills that result in beach closures and other sources of pollution exist year-round.

In response to the poor water quality and significant exceedences of bacterial indicators revealed through monitoring at California's beaches, the Clean Beaches Initiative (CBI) Grant Program was initiated by Assembly Bill 411 (Statutes of 1997, Chapter 765). The water quality goal of the CBI is to make beaches safe for recreational ocean water contact. The CBI Grant Program provides funding for projects that restore and protect the water quality and the environment of coastal waters, estuaries, bays, and near-shore waters. Scientific studies have shown that water with high bacteria levels can cause infections, rashes, and gastrointestinal and respiratory illnesses (SWRCB Clean Beaches Initiative 2001).

The CBI Grant Program has provided about $100 million from voter-approved bonds for approximately 100 projects since it began under the 2001 Budget Act. Typical projects include the construction of disinfecting facilities, diversions that prevent polluted storm water from reaching the beach, and scientific research that will enable early notification of unhealthy swimming conditions.

California beaches are an important environmental and economic resource for the state and the nation. Efforts such as the CBI that fund stormwater diversions and other water quality improvement projects are creating benefits that will likely far outweigh their costs. For more information on CBI, go to http://www.swrcb.ca.gov/water_issues/programs/beaches/cbi_projects/index.shtml.

Irrigated Agriculture

In 2012, the Central Valley RWQCB adopted general waste discharge requirements for growers in the Eastern San Joaquin River watershed that are members of the third-party group (East San Joaquin Water Quality Coalition) representing the area. The order covers an estimated 3,600 growers with 835,000 acres under production. The Central Valley RWQCB estimates that the total cost of compliance with this order is expected to be approximately $99 million dollars per year or $119 per acre annually. Approximately $113 of the $119 per acre annual cost is associated with implementation of management practices to protect surface and groundwater quality. Other costs included in the total amount are third-party costs (monitoring, reporting, tracking, and administration), state fees, and farm plans (Central Valley RWQCB 2012a).

Major Implementation Issues

Irrigated Agriculture

Many surface water bodies are impaired because of pollutants from agricultural sources. Statewide, approximately 7,986 miles of rivers/streams and some 310,370 acres of lakes/reservoirs are on the state's impaired water bodies list or Clean Water Act 303(d) list as being impaired by runoff from irrigated agriculture. Agricultural discharges including irrigation return flow, flows from tile drains, and stormwater runoff affect water quality by transporting pollutants such as pesticides, sediments, nutrients, salts (including selenium and boron), pathogens, and heavy metals from cultivated fields into surface waters. Groundwater bodies have also suffered pesticide, nitrate, and salt contamination. A recent report by UC Davis titled *Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater* (Harter et al. 2012) found that agricultural fertilizers and animal wastes applied to cropland are by far the largest regional sources of nitrate in groundwater in the Tulare Lake basin and Salinas Valley.

In an effort to control and assess the effects of discharges from irrigated agricultural lands, the Los Angeles, Central Coast, Central Valley, and San Diego RWQCBs have adopted comprehensive conditional waivers of waste discharge requirements. The Colorado River and North Coast RWQCBs have adopted Conditional Prohibitions as a TMDL implementation plan incorporated into their respective basin plans, and the Santa Ana Region RWQCB is in the initial phase of developing an irrigated lands regulatory program. In the future, other RWQCBs may also adopt waivers for agricultural discharges in order to implement TMDLs. An estimated 40,000 growers, who cultivate more than 9 million acres, are subject to RWQCBs' irrigated agriculture regulatory programs in these regions. These RWQCBs have made significant strides to implement their irrigated agriculture regulatory programs and are committed to continue their efforts to work with the agricultural community to protect and improve water quality.

Urban Impacts

Urbanization alters flow pathways, water storage, pollutant levels, rates of evaporation, groundwater recharge, surface runoff, the timing and extent of flooding, the sediment yield of rivers, and the suitability and viability of aquatic habitats. The traditional approach to managing urban and stormwater runoff has generally been successful at preventing flood damage, but it has several disadvantages. In order to convey water quickly, natural waterways are often straightened and lined with concrete, resulting in a loss of habitat and negatively impacting natural stream physical and biological processes. Urbanization creates impervious surfaces, meaning stormwater does not infiltrate into subsurface aquifers. This increases runoff volumes and velocities, resulting in streambank erosion and potential flooding problems downstream.

Urban runoff from both storm-generated and dry weather flows has also been shown to be a significant source of pollution by washing contaminants such as nutrients (lawn fertilizers and pet wastes), pesticides, oil and grease, metals, organic chemicals, human pathogens, and debris (especially plastics and plastic particulates) from city streets and other hard surfaces into surface waters and beaches.

One approach to address urban runoff is the watershed approach, which attempts to emulate and preserve the natural hydrologic cycle that is altered by urbanization. The watershed approach consists of a series of Best Management Practices designed to reduce the pollutant loading and reduce the volumes and velocities of urban runoff discharged to surface waters. These Best Management Practices may include facilities to capture, treat, and recharge groundwater with urban runoff, public education campaigns to inform the public about stormwater pollution, including the proper use and disposal of household chemicals, and technical assistance and stormwater pollution prevention training. Additional information is available in Chapter 20, Urban Stormwater Runoff Management and Chapter 25, Recharge Area Protection in this volume.

Legacy Pollutants

Arsenic, asbestos, radon, minerals, and sometimes microorganisms and sediment are examples of naturally occurring contaminants for which a pollution prevention approach is not applicable. Furthermore, some contaminants that are of concern specifically for drinking water, such as arsenic found to occur naturally in groundwater, organic carbon from watershed runoff, and bromide from ocean salinity, are a result of natural processes for which a pollution prevention approach is not possible. While there are natural sources of organic carbon, anthropogenic sources from agriculture drainage, urban runoff, and wastewater discharges typically contain higher concentrations of organic carbon than natural runoff.

Abandoned mines and former industrial and commercial sites, such as gas stations and dry cleaning operations, often leave behind contamination problems without a clear link to any legally responsible or financially viable party or entity to pay for the cleanup. State and federal governments and potentially responsible parties often become involved in extensive regulatory and legal proceedings to determine the legal and financial responsibility while the contaminants remain.

Contaminants of Emerging Concern

Traditionally, drinking water systems focus on pathogens (disease-causing microorganisms), chemicals, and disinfectant by-products (potential cancer-causing contaminants) that are regulated or will be regulated in the near future. Recently, other unregulated chemicals and pollutants have been discovered to have unexpected health and environmental effects. Chemicals found in pharmaceuticals and personal care products (PPCPs), by-products of fires and fire suppression, and discarded elements of nanotechnology are emerging as actual or potential water contaminants. Most of these emerging pollutants have not yet been subject to rigorous assessment or regulatory action.

The SWRCB is preparing an amendment to the Recycled Water Policy to include monitoring requirements for constituents of emerging concern (CECs) in recycled water for indirect potable reuse (i.e., groundwater recharge of a drinking water aquifer). In addition, to assess the aquatic life impacts of pharmaceutical discharges, the State has recently contracted for research in development and evaluation of bioanalytical screening or bioassay techniques for potential application in recycled water monitoring. The goal is to develop high throughput bioassays for the screening of compounds for specific biological target activities (e.g., endocrine disruption, etc.).

Institutional Barriers

Institutional barriers can contribute to the difficulty of addressing pollution from uncontrolled runoff, especially as the state moves towards a broader watershed approach to pollution prevention and regulatory action. Various state, local, and federal agencies have divided jurisdiction over groundwater versus surface waters, polluted runoff versus point-source discharges, water quantity versus water quality issues, and even over monitoring and assessing pollutants. These various “stovepipes” of regulatory authority can hamper the more holistic watershed approach to water quality management, and will need to be addressed in the coming years. Management and regulation of water quality in California is fragmented among at least eight state and federal agencies, and no one agency is totally responsible for water quality from source to tap. For example, the SWRCB and RWQCBs regulate ambient water quality, while the Department of Public Health primarily regulates treatment and distribution of potable water. Further, surface water storage and conveyance in California is managed mostly by the Department of Water Resources and the U.S. Bureau of Reclamation, while groundwater is usually not managed in a coordinated manner at all. Moreover, providing drinking water to Californians is an obligation of cities, water districts, private water companies, and small water systems that generally were not formed in any comprehensive pattern.

Efforts to coordinate, collaborate, and leverage various agency authorities towards improvements of water quality in California have been initiated and will need to continue in order to alleviate these institutional barriers. Finally, the diffuse nature of NPS pollution and the need to control sources on private and public land adds to the difficulties of instituting pollution prevention measures.

Climate Change

Climate change may exacerbate concentrations of pollutants in rivers and lakes from multiple sources. Higher temperatures will cause more algal blooms, reducing dissolved oxygen levels and decreasing filter capacity. Storm events following forest fires may result in increased deposition of pollutants in waterways. Also, pesticide application may increase as more pests survive warmer and drier winter conditions. In the urban environment, the projected stronger storms may also overwhelm urban stormwater systems, leading to additional dispersion of pollutants into waterways.

Adaptation

New standards for land use and development, such as fewer impervious surfaces, more on-site use of rainwater, and more vegetated areas should assist to reduce the amount of pollution in populated areas. Forest management techniques, such as small biomass removal and integrated pest management practices, can also reduce the likelihood of catastrophic fires and increased pesticide use to combat pest infestations. Another adaptation measure may include higher levels of treatment for discharges into rivers and lakes. In the agricultural sector, reduced application of nitrogen-based fertilizers could advance adaptation by maintaining groundwater quality for beneficial uses.

Mitigation

Vehicles are one of the major mobile (non-point) sources of pollution. Shifts to reduce vehicle use and away from gasoline-fueled vehicles may reduce the volume of pollutants entering waterways. Fewer pollutants could result in reduced water treatment needs, which would mean less energy usage and fewer GHG emissions. Further adoption of low-impact development measures could also reduce pollution in urban settings. In agricultural settings, additional use of integrated pest management and reduced fertilizer application techniques could reduce the energy use associated with pesticide application and groundwater nitrates treatment. In recognition that biomass resources generated by agriculture can be used as an energy source and as a strategy to address climate change, the dairy industry developed digester facilities that produce electricity from dairy manure. The Central Valley RWQCB supported this effort with the adoption of general waste discharge requirements (Order R5-2010-0116 and R5-2011-0039) that streamline the permitting process for these facilities.

Onsite Wastewater Treatment Systems (OWTS)

In 2012, the SWRCB adopted an Onsite Wastewater Treatment Systems (OWTS) policy to allow continued use of OWTS while protecting water quality and public health. The use of OWTS, including septic tanks and leachfields, can be an effective means of treating and disposing of domestic wastewater in rural locations where centralized wastewater treatment systems are not available . However, there have been occasions in the state where OWTS, for various reasons, have not satisfactorily protected either water quality or public health. Some instances of these failures are related to the OWTS not being able to adequately treat and dispose of waste as a result of poor design or improper site conditions. Others have occurred where the systems are operating as designed, but their densities are such that the combined effluent resulting from multiple systems is more than can be assimilated into the environment. From these failures, California must learn how to improve usage of OWTS and prevent such failures from happening again.

As California's population continues to grow, and there are both increased rural housing densities and the building of residences and other structures in more varied terrain than ever before, there are increased risks of causing environmental damage and creating public health risks from the use of OWTS. What may have been effective in the past may not continue to be effective as conditions and circumstances surrounding particular locations change. So necessarily, more scrutiny of OWTS installation is demanded from all those involved while maintaining an appropriate balance of only the necessary requirements so that the use of OWTS remains viable.

Wastewater Infrastructure Needs

While great strides have been made in providing treatment of wastewater before being discharged to surface waters, much of the wastewater treatment infrastructure has exceeded its useful life expectancy. Without continued upgrade and replacement, the failure rates of wastewater treatment facilities could increase, thereby degrading the surface waters that receive the effluent from these facilities.

Because climate change predicts changes in streamflow patterns, the historic assimilative capacity of streams with respect to wastewater discharges would need to be re-evaluated. Treatment processes may need to be upgraded to more advanced levels. In addition, advances in knowledge of the impacts of emerging contaminants may necessitate more implementation of more advanced treatment processes.

Recommendations

1. Pollution prevention and management of water quality impairments should be based on a watershed approach. A watershed-based approach adds value, reduces cost, promotes cross-media, and integrates programmatic and regional strategies.
2. The Department of Water Resources should collaborate with the SWRCB to integrate the basin plans and other statewide water quality control plans and policies into a comprehensive water quality element of the California Water Plan.
3. The California Water Quality Monitoring Council should include a focus on emerging, unregulated contaminants in order to provide an early warning system of future water quality problems, as well as identify trends in water quality using multiple indicators of health. Drinking water supplies should have outcome-based monitoring, such as biomonitoring and waterborne disease outbreak surveillance. The proposed Interagency Water Quality Program would be

modeled after the existing Interagency Ecological Program. The groundwater portion of this effort should be consistent with the recommendations of the Groundwater Quality Monitoring Act of 2001 and DWR Bulletin 118, while the surface water aspects should be coordinated with the SWRCB's Surface Water Ambient Monitoring Program.

4. Regional, tribal, and local governments and agencies should establish drinking water source and wellhead protection programs to shield drinking water sources and groundwater recharge areas from contamination. These source protection programs should be incorporated into local land use plans and policies.

Pollution Prevention in the California Water Plan

This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions are not consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy is not discussed in the rest of Update 2013), there is no need for this section to appear.]

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Box 18-1 Central Coast Ambient Monitoring Program

The Central Coast Ambient Monitoring Program (CCAMP) is the Central Coast's regional component of SWAMP. CCAMP plays a key role in assessing Central Coast regional goals and has a number of program objectives: (1) assess watershed condition on a five-year rotational basis using multiple indicators of health, (2) assess long-term water quality trends at the lower ends of coastal creeks, (3) conduct periodic assessments of harbors, estuaries, lakes, and near-shore waters using multiple indicators of health, and (4) support investigations of other water quality problems including emerging contaminants, sea otter health, pathogenic disease, toxic algal blooms, and others.

Box 18-2 Central Valley Drinking Water Source Policy

Public water systems that use surface waters must comply with increasingly stringent laws and regulations designed to provide increasing protection for public health. In August 2000, the CALFED Bay-Delta Program issued a Record of Decision (ROD) requiring the California Bay-Delta Authority, with the assistance of Department of Public Health (DPH), to coordinate a comprehensive Source Water Protection Program. One element of this Source Water Protection Program is to establish a Drinking Water Policy for the Delta and upstream tributaries.

A multi-year effort is currently underway to develop a drinking water policy for surface waters in the Central Valley. As water flows out of the Sierra foothills and into the Central Valley, pollutants from a variety of urban, industrial, agricultural, and natural sources affect the quality of water, which leads to drinking water treatment challenges and potential public health concerns. Current policies and plans lack water quality objectives for several known drinking water constituents of concern, such as disinfection by-product precursors and pathogens, and do not include implementation strategies to provide effective source water protection. The types of regulatory requirements that will be included in the drinking water policy have not been determined, but the goal is to develop a policy that provides clear guidance to ensure consistent source water protection. The Central Valley Regional Water Quality Control Board has been working with a workgroup made up of interested stakeholders including federal and state agencies, drinking water agencies, and wastewater, municipal stormwater and agricultural interests, to develop a drinking water policy to help protect drinking water supplies. Additional information is available at http://www.waterboards.ca.gov/centralvalley/water_issues/drinking_water_policy/index.shtml.

Box 18-3 U.S. EPA Non-point-Source Success Stories

The U.S. EPA has highlighted a number of Non-point-source Success Stories that were identified by states as being primarily non-point-source-impaired and having achieved documented water quality improvements. These highlighted projects have received funding from Clean Water Act (CWA) section 319 and/or other funding sources dedicated to solving non-point-source impairments. The California success stories include the following water bodies:

- Big Meadow Creek and Upper Truckee River.
- Chorro Creek.
- Sacramento and Feather Rivers.
- San Diego Creek.
- San Joaquin Basin (Grasslands Watershed).
- San Joaquin River.
- Whiskeytown Lake.

These success stories are available at http://water.epa.gov/polwaste/nps/success319/index.cfm.

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Chapter 22. Ecosystem Restoration

Ecosystem restoration improves the condition of California's modified natural landscapes and biological communities to provide for their sustainability and for their use and enjoyment by current and future generations. Few, if any, of California's ecosystems can be fully restored to their pre-development condition. Instead, efforts focus on rehabilitation of important elements of ecosystem structure and function. Successful restoration increases the diversity of native species and biological communities and the abundance of habitats and connections between them. This can include reproducing natural flows in streams and rivers, curtailing the discharge of waste and toxic contaminants into water bodies, controlling non-native invasive plant and animal species, removing barriers to fish migration in rivers and streams, and recovering wetlands so that they can store floodwater, recharge aquifers, filter pollutants, and provide habitat.

Overview

This strategy focuses on restoration of aquatic, riparian, and floodplain ecosystems because they are the natural systems most directly affected by water and flood management actions, and are particularly vulnerable to the impacts of climate change. Today, water and flood planning must prevent ecosystem damage and reduce long-term maintenance costs. Future water and flood management projects that fail to protect and restore their ecosystems will face reduced effectiveness, sustainability, and public support.

Restoration generally emphasizes recovery of at-risk species and natural communities, usually those whose abundance and geographic range have greatly diminished. These include several fishes, such as delta smelt, longfin smelt, green sturgeon, Chinook and coho salmon, and steelhead rainbow trout. Also included are riparian and wetland habitats and their member species, including valley elderberry longhorn beetle, giant gartersnake, and several migratory bird species. Successful restoration of aquatic, riparian, and floodplain species and communities ordinarily depends upon at least partial restoration of the physical processes that are driven by water. These processes include the flooding of floodplains, the natural patterns of erosion and deposition of sediment, the balance between infiltrated water and runoff, and substantial seasonal variation in stream flow. Another barrier to ecosystem restoration — displacement of native species by exotics — often results from the diminution of these same physical processes.

As an example, nearly all California waterways are controlled to reduce the natural seasonal variation in flow. Larger rivers are impounded to capture water from winter runoff and spring snowmelt and release it in the dry season. Many naturally intermittent streams have become perennial, often from receipt of urban wastewater discharges or from use as supply and drainage conveyances for irrigation water. The Sacramento-San Joaquin Delta (Delta) has become more like a year-round freshwater lake than the seasonally brackish estuary it once was. In each case, native species have declined or disappeared. Exotic species have become prevalent, often because they are better able to use the greater or more stable summer moisture and flow levels than the drought-adapted natives are.

Current Activities

Many important recovery efforts that affect water and flood management occur throughout California and are performed by public agencies, private agencies, non-profits, volunteers, or a combination of all the above. Some examples appear below.

The first example of recovery and restoration planning is in the Delta, where several efforts are under way. Water users are seeking to secure long-term assurances for Delta exports by formulating a Bay Delta Conservation Plan (BDCP). BDCP will identify how to improve the design and operation of the State and federal water projects and restore and manage habitats in the Delta. Once adopted, the BDCP will be implemented over the next 50 years. The schedule for release of the draft EIR/EIS is summer, 2012. The Sacramento-San Joaquin Delta Reform Act of 2009 (Delta Reform Act) established a Delta Stewardship Council to develop a Delta Plan. State and local agency actions related to the Delta must be consistent with the Plan. The Delta Reform Act also required the State Water Resources Control Board (SWRCB) to develop flow criteria for the Delta ecosystem. The Board approved a staff report on development of flow criteria in August 2010 and submitted it to the Delta Stewardship Council.

Another example of restoration planning is the Central Valley Project Improvement Act (CVPIA) of 1992, which mandates changes in the management of the Central Valley Project, particularly for the protection, restoration, and enhancement of fish and wildlife. One component of the CVPIA is the Anadromous Fish Restoration Program (AFRP). The AFRP has a goal of at least doubling the natural production of anadromous fish in Central Valley streams. AFRP has helped implement nearly 200 projects to restore natural anadromous fish production.

A third example is the Central Valley Joint Venture (CVJV), which protects, restores, and enhances wetlands and associated habitats for waterfowl, shorebirds, and songbirds in the Central Valley through partnerships among conservation organizations, government agencies, and private landowners. The CVJV Implementation Plan focuses on wetlands and the values they provide to birds. It contains Central Valley-wide objectives, expressed as acres of habitat of seasonal and semi-permanent wetlands, riparian areas, rice cropland, and other waterfowl-friendly agricultural crops.

Fourth, the Southern California Wetlands Recovery Project, chaired by the California Natural Resources Agency and supported by the Coastal Conservancy, works to acquire and restore wetlands, watersheds, and streams in coastal Southern California. The aim is to reestablish a mosaic of fully functioning wetlands with a diversity of habitat types and connections to uplands to preserve self-sustaining populations of species. About 120 projects are in-process or are completed, with more than 2,700 acres acquired and protected and more than 800 acres enhanced or restored. These include Tijuana Estuary, South San Diego Bay National Wildlife Refuge, the Bolsa Chica and Ballona wetlands, and the Santa Clara River Parkway.

The final example is the Santa Ana River Watershed Program that successfully integrates habitat restoration and endangered species recovery with flood control, groundwater recharge, and water quality improvement. Prado Dam is a key component, serving both flood protection and water storage. There is a habitat area upstream of the dam that has expanded over the last 20 years to support both the largest patch of riparian forest and the largest number of the endangered Bell’s vireo (a songbird) in Southern California. The invasive giant reed (arundo) displaces native vegetation along the river, impedes flow during floods, and is a heavy water user. An aggressive program of giant reed removal serves to improve habitat for the vireo, reduce flood risk, and recover more water. The river is the main source of recharge for the Orange County Groundwater basin and consists mainly of treated wastewater from upstream cities. Constructed wetlands remove nitrogen from river water.

Potential Benefits

Provision of Ecosystem Services

California rivers and their associated floodplain ecosystems provide numerous public and private benefits that can be thought of as goods and services. These include water purification, groundwater recharge, erosion control, storage of floodwaters, hydropower generation, soil-building, pollination, wood products, carbon sequestration (greenhouse gas mitigation), fisheries, wildlife, and recreation.

Market opportunities for nature's services, often called "payments for ecosystem services", are contracts negotiated with landowners to manage land and water so as to maintain or enhance the specified services. A new direction in efforts to protect and restore ecosystems is to develop those markets. Numerous pilot projects are under way in California and elsewhere. These typically involve collaboration among diverse interests, agreement on a geographic boundary, identification of management practices, and – often the hardest step – economic valuation of the benefits derived from the practices. The projects also must identify beneficiaries and establish mechanisms for them to pay for the goods and services they receive.

Estimation of the monetary value of nature's services can be important information for resource managers who normally see only the costs of ecosystem protection, but not the benefits, in their budgets. Examples of current and emerging projects appear in Volume 2, *Regional Reports*, and include the following: farming for carbon capture and land subsidence reversal on islands in the Delta; forest, water, and fire management in the Mokelumne River watershed; mountain meadow improvement in the Sierra and Cascades; and natural resource management in the Santa Ana River watershed.

A recent initiative by the California Department of Conservation and the Environmental Defense Fund (the "Conservation Pivot") assesses the policy framework that supports conservation on farms and ranches. It concludes that broader use of economic incentives to measure and produce ecosystem services on privately owned lands is the key, both to protecting farms and ranches and to preserving and enhancing nature's services, in the face of population growth, infrastructure demands, and climate change.

Reliability of Water Supply

As ecosystem restoration actions help recover the abundance of endangered species, fewer Endangered Species Act conflicts should occur, particularly in the Delta. These conflicts repeatedly disrupt water supplies. Thus, one result of ecosystem restoration should be a more reliable water supply.

An example of a more direct water supply benefit is the restoration of meadows that occur in the headwaters of rivers and streams. Meadows have wide, shallow vegetated channels that spread flood peaks across the meadow floodplain and recharge the underlying aquifer. In contrast, gully erosion drains groundwater stored in meadows and eliminates meadow wetlands. Meadow restoration reverses gully erosion and returns the vegetation to wetland and riparian forms. The U.S. Forest Service estimates that meadow restoration in national forests in the Sierra Nevada could add 50,000 to 500,000 acre-feet of groundwater storage per year. See Chapter 23, "Forest Management," in this volume for further discussion.

Water Quality

The numerous ways that natural ecosystems contribute to water quality improvement are described in other resource management strategies in this volume. For the role of wetlands and riparian forests in filtering contaminants from runoff, see Chapter 18, “Pollution Prevention,” and Chapter 23, “Forest Management.” Chapter 23 describes the role of forests in preventing erosion and subsequent sedimentation of streams. Finally, Chapter 27, “Watershed Management,” explains that drinking water drawn from forested land requires less treatment than water derived from agricultural or developed land because it is less contaminated.

Sustainability

Water and flood management projects that incorporate ecosystem restoration are likely to be more sustainable than those that do not. Projects are more sustainable (that is, they operate as desired with less maintenance effort) when they work with, rather than against, natural processes that distribute water and sediment. Including ecosystem restoration in a project usually requires a degree of return to more natural patterns of erosion, sedimentation, flooding, and instream flow, among others. This, in turn, makes such projects more resistant to disruption by the natural processes, which makes these projects easier to maintain. As expected, cost savings over the life cycle of the projects accrues as a benefit, because repair and maintenance will cost much less.

Climate Change Mitigation and Adaptation

Ecosystem restoration can play a large role in climate change mitigation. Because plant growth depends on the capture and incorporation of atmospheric carbon into plant tissue, trees and other plants sequester carbon. Growth rates of trees in low-elevation riparian forests in California are among the highest in the world, outside except the tropics. Thus, significant expansion of riparian forest acreage in inland and coastal valleys could serve as a large carbon sink that offsets carbon emissions. Although construction activities during restoration could produce some greenhouse gases, those emissions should be far less than the total of greenhouse gases sequestered through forest growth.

Ecosystem restoration can also play a role in climate change adaptation. The Central Valley Flood Protection Plan outlines the State’s proposed response to a predicted climate regime of more frequent and larger floods. Part of that response is to increase the use of floodwater bypasses by creating new ones and widening the existing set. Beyond their role in flood protection, bypasses return floodplains to a more natural function and allow restoration of native floodplain vegetation. In turn, this helps to stabilize soils, increase groundwater infiltration and storage, and reduce floodwater velocities, bank erosion, and sedimentation of streams. Furthermore, because a return to a more natural floodplain function makes more room for flood peaks in valley areas, it allows more reservoir capacity to be dedicated to water supply, rather than be set aside for floodwater storage.

The expected shift to more severe flooding may diminish the ability to continue to farm many areas because the increased cost of recovery from floods could make farming uneconomical. However, making a clear dedication of land to expand flood-carrying capacity will reduce the flood risk on the remaining farmland and thus make that land more secure for agriculture.

Flood Management

The principal opportunities for improvement in both flood and habitat management occupy the same spatial footprint and are affected by the same physical processes that distribute water and sediment in rivers and across floodplains. As suggested above, many actions taken for ecosystem restoration can also support more sustainable flood management.

Four major structural elements of flood management in California affect ecosystems: dams, levees, floodwater bypasses, and setback levees. Their flood management roles are clear. Dams impound floodwater and reduce peak flows. Levees keep rivers in their channels and off their floodplains. Bypasses allow controlled conveyance of floodwater across floodplains. Setback levees reduce water velocities and flood elevations, when compared to on-channel levees, and therefore sustain less erosion damage.

The combined use of dams and levees reduces the frequency and extent of floodplain inundation. In contrast, setback levees and bypass channels allow more frequent inundation of potential habitat space on floodplains. Native riparian and aquatic animal and plant communities of California are adapted to seasonal flooding conditions. Thus, setback levees and bypasses are better tools to integrate habitat and flood protection than dams and on-channel levees. Flood bypasses, in particular, can serve as important fish rearing habitat, which is a use of the Yolo Bypass today. The Yolo Bypass provides juvenile salmon with far better growth and survival opportunities than do the nearby channelized rivers that are now their main habitat.

Ecosystem restoration can improve flood protection by reducing levee erosion, increasing floodwater conveyance, deflecting dangerous flows away from levees, and strengthening levee surfaces. For example, levee erosion is a maintenance concern that often can be alleviated by slowing water velocity along the levee face. This can be done by setting the levee back and by growing plants on the lower levee slope and between the levee and the main channel. The vegetation reduces the force of water against the levee. Also, a new setback levee can be built with sound materials on a more stable foundation than many existing levees. The selection of appropriate vegetation is a key to reducing levee erosion while retaining the flood-carrying capacity of the stream channel.

A recent example of the use of suitable plants occurred at O’Connor Lakes on the Feather River, downstream of Yuba City, where a right-angle bend in the levee had been subject to severe and repeated erosion. A technical analysis of the paths taken by floodwater identified areas of the river channel where forest could remain (instead of being cleared periodically), areas where restoration of native trees and shrubs would not interfere with flood flows, and areas where the vegetation needed to be low and flexible enough to smooth the way for floods. The latter area was planted with native grasses and herbs. Overall, the new design increased the area of native vegetation by 230 acres, protected existing habitat from removal, reduced the risk of levee erosion and the need for expensive levee repair, and reduced the cost of keeping the channel clear for floodwater conveyance. Thus, a cheaper and more effective way to maintain the flood channel was also better for fish and wildlife habitat.

As with floodwater bypasses, habitat for juvenile fishes can be developed with setback levees. One such project on the lower Bear River in Sutter County was contoured to drain water and fish back to the river when floodwaters recede, thus preventing fish stranding. The project also created several hundred acres of forest and grassland habitat. The new, larger more durable levee, set back from the erosive forces of the river, improved flood protection for the urban area behind it.

Potential Costs

A comprehensive statewide summary of the costs of ecosystem projects does not exist. However, as of 2011, the Ecosystem Restoration Program, now managed by California Department of Fish and Wildlife, had funded 579 projects, worth about $718 million. About half of that amount was spent for riparian habitat, fish screens and improvements to water and sediment quality.

Under the authority of the Central Valley Project Improvement Act, State and federal government spent about $630 million for fish and wildlife restoration since 1992 (U.S. Department of the Interior 2005).

The Central Valley Joint Venture has used a mix of public and private funds to accomplish its goals. Table 22-1 below (updated March 2011) illustrates the budgets and the acres of habitat conserved (Central Valley Joint Venture 2011).

PLACEHOLDER Table 22-1 Acres Conserved by Central Valley Joint Venture

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

As of 2010, the Southern California Wetlands Recovery Project has spent more than $450 million completing projects from Santa Barbara County to San Diego County (Southern California Wetlands Recovery Project 2010).

Major Implementation Issues

Climate Change

Climate change will likely make preservation and restoration of key habitats more difficult. Perhaps the most important reason for this is an expected decline in the availability of moisture. A combination of rising temperatures, more intense floods, a smaller snowpack, more frequent drought, and more frequent and intense wildfires will reduce both surface and groundwater storage as more water runs off or evaporates and less water infiltrates into the ground. These changes in temperature and moisture will force species and natural communities to move with their preferred temperature and moisture regimes — uphill, northward, and into cool canyons — until blocked by topographic or other barriers. The result is that many species and ecosystems will occupy ever smaller and more isolated patches of physical habitat. As their abundance declines, more species will risk extinction.

Two examples are especially relevant to water and flood management. First, in many low- and middle-elevation streams today, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water temperatures will exacerbate this problem. As the timing of peak tributary runoff shifts toward winter, less of the winter flow is likely to be captured in reservoirs. This will leave less cold water for fish in spring and summer. Thus, climate change might require dedication of more water simply to maintain existing fish habitat, and plans to expand habitat will face stiffer competition from other demands on water.

The second example results from the continued rise in sea level and upstream encroachment of salt water. As this happens, the brackish and fresh aquatic habitats of the Sacramento-San Joaquin Estuary, which are critical to many at-risk species, will shift upstream and inland. Continuing urbanization on the edges of the Delta will limit opportunities to acquire or restore lands that could provide suitable habitat. Thus, threatened and endangered species could be increasingly squeezed between the inland sea and the encroaching cities.

Conflicting Objectives with Traditional Flood Management

Ecosystem restoration and traditional flood management often have conflicting objectives. Traditional flood planning assigns all the physical space in a river channel to floodwater conveyance and leaves little room for habitat values. Many of the greatest opportunities for ecosystem restoration, especially in the Central Valley and other valleys, require incorporation of habitat into the flood protection system. At this early stage in statewide flood planning, there is a lack of consensus on how to design such an integrated system and on the desirability thereof. For example, many would balk at using newly-created flood capacity in a river channel to make room for forests.

Californians need to be satisfied that the promise of an integrated approach to flood and ecosystem management can provide habitat without greater risk of flood damage. A habitat project that fails to achieve its objectives is costly, but not dangerous. In contrast, a flood protection project that fails can mean catastrophe for life and property.

Opposition to Conversion of Farmland to Habitat

Many of the opportunities for ecosystem restoration are on land that is now farmed, especially in the Central Valley and the Delta. Although some habitat types, such as seasonal wetlands, can be farmed at other times of year, others, such as riparian forest and most permanent wetlands, cannot. Thus, significant amounts of habitat restoration on arable land, coupled with continued urban growth, could hasten the decline of some forms of agriculture in California. The loss of farmland, especially for habitat uses, is controversial.

Instream Flows

Restoration of adequate instream flows and channel and floodplain form and function is a priority for the California Department of Fish and Wildlife (DWF). DFW has legal mandates to determine flows that will ensure the viability of fish and wildlife, identify the watercourses to evaluate, initiate flow studies, and develop and submit recommendations to the SWRCB for use in allocating water. Much work remains to complete studies and develop recommendations. Until then, incomplete knowledge will hamper restoration of adequate stream flows.

Mercury Contamination

Wetland restoration carries the potential for methylmercury contamination. Some seasonally and permanently flooded wetlands can convert elemental mercury to methylmercury. Methylmercury is highly toxic and can accumulate in natural food chains and in fish that people eat. Many areas targeted for habitat restoration, particularly in and near the Delta, are contaminated with mercury. Hence, wetland restoration in those areas could exacerbate methylmercury production. The SWRCB approved a basin plan amendment for the control of methylmercury and total mercury in the Delta in 2011. The regulation requires wetland project proponents to take part in evaluations of practices to reduce methylmercury discharges and apply controls.

Recommendations

1. Devise climate change adaptations that benefit both ecosystems and water and flood management. The principal predicted effect of climate change on California ecosystems is that it will further fragment and shrink them. Thus, appropriate corrective actions should serve to reconnect and expand them. The overarching recommendation is to establish large biological reserve areas that connect or reconnect habitat patches. These proposed “landscape reserves” are discussed further in the biodiversity and habitat section of the California Natural Resources Agency’s Climate Adaptation Strategy (2009). More specific measures that can help ecosystems adapt to climate change are those that integrate ecosystem restoration into flood and water projects. The following measures were discussed above:
    A. Reconnect rivers to their historic floodplains as part of new flood management approaches.
    B. Increase the use of setback levees and floodwater bypasses.
    C. Expand lowland riparian forest acreage in the form of continuous corridors along watercourses.
    D. Set aside habitat in the Delta to compensate for habitat lost to sea level rise.
    E. Restore mountain meadows.
2. Promote multidisciplinary approaches to water and flood management. Conflicting objectives are commonplace in water and flood planning which makes it essential to foster broad participation and collaboration among the affected parties to generate a shared vision of water and flood management that incorporates multiple interests. One promising approach is to devise a system of payments for ecosystem services in which beneficiaries pay natural resource managers for practices that support and enhance the desired goods and services. Stakeholders must identify and agree on what the relevant goods and services, the beneficiaries, and the monetary value of the benefits are.
3. Expand financial incentives for farmers to grow and manage habitat. Programs such as the Environmental Quality Incentives Program administered by the USDA, Natural Resources Conservation Service (NRCS) and DWR’s Flood Corridor grant program are examples of the direction that expansion could take. See Chapter 21, “Agricultural Land Stewardship,” in this volume for further discussion.
4. Provide for instream flow needs. Provide a comprehensive and appropriately funded program to identify instream flow needs, perform the necessary studies, and make scientifically defensible recommendations for instream flows to protect fish and wildlife.
5. Continue collaboration between wetland stakeholders and Regional Water Quality Control Boards (RWQCBs) to reduce mercury contamination. Wetland stakeholders are working with the RWQCBs to identify and conduct research to reduce human and ecosystem exposure to mercury without preventing other efforts to improve ecosystem health through wetland restoration.

Ecosystem Restoration in the Water Plan

[This is a new heading for *California Water Plan Update 2013* (Update 2013). If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions are not consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy is not discussed in the rest of Update 2013), there is no need for this section to appear.]

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Table 22-1 Acres Conserved by Central Valley Joint Venture

NAWCA	Acres Conserved[a]	NAWCA Grant Funding	Federal Funding[b]	Non-Federal Partners[c]
All of California	714,000	$72,000,000	$109,000,000	$230,000,000
North Central Valley/Delta	341,400	$32,300,000	$82,000,000	$85,200,000
Southern Central Valley	258,600	$21,000,000	$21,700,000	$56,600,000

Notes:

[a] Reflects habitat protected, restored, and enhanced.

[b] This column reflects additional Federal partner contributions.

[c] This column reflects non-federal partner contributions.